REPORT No. 7.

U. S. DEPARTMENT OF AGRICULTURE.

FIBER INVESTIGATIONS.

A REPORT

ON

THE CULTIVATION OF RAMIE

IN

THE UNITED STATES,

WITH

STATEMENTS CONCERNING THE PRACTICE IN FOREIGN COUNTRIES, COST OF CULTIVATION AND PERCENTAGES OF YIELD, THE MACHINE QUESTION, AND PREPARATION OF THE FIBER FOR MANUFACTURE.

BY

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LETTER OF SUBMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF FIBER INVESTIGATIONS,
Washington, D. C., April 1, 1895.

SIR: I have the honor to submit herewith the manuscript for Report No. 7 of the Fiber Investigations series, on the cultivation of ramie in the United States. The publication of this report is important at this time in view of the fact that there is great inquiry for reliable information regarding this promising textile plant, and also because the literature of the subject is meager as it relates to the practical considerations of culture, cost of establishing plantations, and possible yields of fiber. The Department publications on this subject were issued several years ago, since which time the situation has changed materially, and on many points the existing literature is now behind the times. In the present report, therefore, the aim has been to tell the whole story of ramie, the discouraging features of the industry as well as its possibilities, in order that farmers desiring to take up its culture may do so understandingly.

I am, respectfully,

CHAS. RICHARDS DODGE,
Special Agent, in Charge of Fiber Investigations.

Hon. J. STERLING MORTON,
Secretary.

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INTRODUCTORY.

A little over four years ago Report No. 1 of the Fiber Investigations series was given to the public. In that document appeared two reports upon the subject of ramie, the first relating to the international trials of ramie machines held in Paris during September, 1889, and the second to a presentation of the status of the ramie question at that time. In the former report an account was given of the official trials of 1889, with tables showing the capacity of the different machines themselves. In the second chapter the entire situation was reviewed, with full statements as to the obstacles and difficulties which had beset the industry and prevented the culture of ramie from becoming remunerative to the agriculturist in this and other countries. A great deal of the testimony presented was discouraging, yet it was shown that something definite had been accomplished; that progress was being made each year, and that ultimate success seemed possible, if not probable. A year later Report No. 2 was issued by this Department, immediately following the extensive trials in Mexico, though at that time, while some ground had been gained in the world's experience, no great progress of a practical nature could be recorded.

In the past two years more substantial progress has been made in several directions. While it can not be stated authoritatively that the machine problem has been solved, an advance in machine construction may be recorded, and several promising new machines have made their appearance. The manufacturing side of the industry has received a considerable impetus, both at home and abroad, and a renewed interest in culture has been awakened, especially in the United States. All this has resulted in a large correspondence with the Department, the special inquiries relating to every phase of the industry from soil selection and culture to the machine question and manufacture. It is important, therefore, to bring the story down to date, to show wherein the situation has been changed, and to supplement the brief statements regarding cultivation and the purely agricultural phases of the industry, as presented in former reports, with a full account of the requirements of successful culture, as well as an outline of the practice involved.

In carrying out this scheme it is the intention to deal only with facts, and to consider the various phases of the industry from the standpoint of practical result; in other words, to tell the truth about ramie, so far as recorded experience will aid us or so far as truth may be sifted from the chaos of misstatement and misinformation that has involved a large part of its literature in our own country, especially the newspaper literature of the past few years.

For the sake of comparison, statements relating to the practice and experience of foreign countries are included, though in no instance without a reference to the authority, in order that the account may be verified if desired. The results of experience in the United States have been presented only after careful examination, and statements of individuals given with full credit; the world's literature of the subject has been consulted, and the correspondents of the Department, in two hemispheres, have aided in the work.

In all the statements regarding the ramie interest the Department has taken a conservative position, appreciating the great harm that is liable to be done any new industry by claiming for it results yet to be proven by practical experience. On some points authoritative statements concerning the ramie interest can not be made until a commercial experiment has been carried out, under expert direction, upon a considerable area, and running over a series of years; and then only when the fiber produced has been carefully tested in manufacture. In this connection the writer desires to express his conviction that the appropriation of public funds for any experiments under the direction of professional promoters is to be deprecated, experience proving that the mere organizer of stock companies is lacking in the practical knowledge requisite for success.

RECENT HISTORY OF THE RAMIE INDUSTRY.

The active interest in rhea began in 1869, when a reward of £5,000 was offered by the Government of India for the best machine with which to decorticate the green stalks. The first exhibition and trial of machines took place in 1872, resulting in utter failure. The reward was again offered, and in 1879 a second official trial was held, at which ten machines competed, though none filled the requirements, and subsequently the offer was withdrawn. The immediate result was to stimulate invention in many countries, and from 1869 to the present time inventors have been interesting in their efforts to produce a successful machine. The commercial history of ramie, therefore, does not extend further back than 1869.

The first records of Chinese shipments of fiber to European markets show that in 1872 200 or 300 tons of the fiber were sent to London, valued at £80 per ton, or about $400. India also sent small shipments, but there was a light demand and prices fell to £30 to £40 per ton for Chinese and £19 to £30 for the India product. In a letter from

Messrs. Ide & Christie, the London fiber brokers, discussing the point of demand and supply, received in 1890, it was stated that ramie ribbons had at no time been shipped to Europe from any country in large quantity. Three hundred or 400 tons during the preceding five years would represent the maximum quantity brought from China, while India and other producing countries had sent little more than sample lots and trial parcels. The largest lot of ramie ever received at any one time was in October, 1888, when 120 to 130 tons of ribbons were offered in the London market. There was nothing like competition for it, and it was sold for £8 to £9, less than half what it cost in China.

Experiments in manufacture in England date back to the sixties, and as early as 1866 the Glover Museum of the Department, which occupied two rooms in the basement of the Patent Office, possessed a series of beautiful ramie fibers and fabrics of English manufacture. There were difficulties, however, in the way of preparing the fiber and in adapting machinery for spinning it that made these processes too costly, and after fortunes had been wasted the effort was abandoned.

Ramie seed is said by Favier to have been first introduced into France in 1836, and in 1844 plants were brought from China by the surgeon of the war ship *Favorite* which were grown in the acclimating gardens. While one writer claims that the plant was first brought to the gardens of Europe in 1733, Favier states that Dr. Fras cultivated the plant in the botanical gardens of Munich in 1850, and that it was grown in Belgium in 1860.

Our own introduction dates back to 1855, but the records seem to show that it did not obtain a foothold in Mexico until 1867, the year, by the way, in which the first American ramie machine was brought to public attention. It is interesting to note that the first shipment of plants into France, in considerable number, was from America, 10,000 plants having been imported for distribution in France and Algiers in 1868. From this time, or a little later, its spread to many other countries was rapid, until now there is hardly a country on the earth where it will grow that has not experimented with cultivation and with the machine question.

The first French official trials took place in 1888, followed by the trials of 1889, in Paris, at which the writer was present, and which are recorded in Report No. 1 of the Fiber Investigations series. Another trial was held in 1891, and in the same year the first official trials in America took place, in the State of Vera Cruz, in Mexico, followed the next year by the first official trials of American machines in the United States; these being followed by the trials of 1894, just closed.

Of the history of the experiments in cultivation in the United States it is not necessary to speak, as the principal attempts at cultivation are recorded or referred to in the reports already published; nor is it necessary to give more than a passing mention to the machine question in America, historically considered.

The first American ramie machine made its appearance over twenty-seven years ago in New Orleans, and was patented by Dr. Benito Roezl in September, 1867. In the circular of the manufacturers of the decorticator it was stated that the extraction and cleaning of the fiber from the stalks was light work and the operation simple, "one machine being sufficient to gin the crops of several large plantations." When we learn that only a small handful of stalks could be cleaned a few feet at a time, as they were held against the revolving knives, and that when cleaned for half their length the fiber was withdrawn and the stalks reversed to clean the opposite ends, it will be readily seen how fallacious was the inventor's claim. It is said that hundreds of the machines were manufactured, and the circulars of the makers were widely distributed, but in spite of the alluring statements that three and four crops of ramie could be produced annually, giving 600 to 800 pounds of fiber per acre worth 60 cents a pound in London, and with less care in cultivation than is given to cotton, the machines remained unsold, and the new industry failed to mature.

Since that time probably a score of American machines have been invented, many of which were never brought to a field trial. The writer has examined many of the machines, and seen the best of them in operation, and recently, while in New Orleans, saw the wrecks of a number of the earlier machines in a "graveyard" of past ramie decorticators on the grounds of Mr. S. B. Allison.

Those who may be interested in pursuing the subject of ramie machines, past and present, will find interesting descriptions, with diagram figures, in the two volumes of the work Traité Scientifique et Industriel des Plantes Textiles, by Filicien Michotte, engineer, Paris, 1891 and 1893. Office Technique, 21 Rue Conderet.

The later French machines and those of American invention are described or referred to in the publications of the Office of Fiber Investigations, so the subject need be pursued no further.

WHAT IS RAMIE?

Ramie, rhea, or China grass, *Bœhmeria nivea*, is a perennial shrub belonging to the *Urticaceæ*, or nettle family of plants. Its native names are: *Tchou-Ma*, China; *Mao*, Japan; *Caloee*, Siam and Sumatra; *Kankhura*, Bengal; *Rhea*, Assam; *Poah*, Nepal; *Goun*, Burmah, and many others.

BOTANICAL CONSIDERATIONS AND HABITAT.

It is claimed to be indigenous in India, and probably also in China. From time immemorial it has been cultivated in China, and has long been grown for its fiber in Japan, Java, Borneo, Sumatra, and the East Indies, and it was introduced into cultivation in the warmer, temperate, and subtropical portions of North and South America, Europe, and Africa. In the United States it has been grown chiefly in the Gulf States and in California, though it has been experimented with

RAMIE—ONE SEASON'S GROWTH IN DISTRICT OF COLUMBIA, 1894.

in cultivation as far north as New Jersey. The plant can not stand frost, and while it may be grown outdoors in some situations north of the Gulf States, it will not mature its two crops, and its growth is uncertain. Mr. R. W. Smith, superintendent of the United States Botanic Garden, considers the District of Columbia the northern limit of growth botanically speaking; but its commercial cultivation, in this locality or in Maryland or Virginia, is out of the question, for only in particularly favorable years will the plant make a satisfactory growth, and even then but a single crop, of doubtful quality of fiber, will be possible. In 1894 the entire season's growth of the little plat at the Botanic Garden was barely 3 feet (see Pl. I), and the clusters of flower racemes had not begun to mature their seed on the 1st of November. Its cultivation northward from the District of Columbia, as in the State of New Jersey, as has been recently suggested, must be set down as a mere vagary. (See cultivation in India, page 13.)

The severity of the past winter in the South has given opportunity to study the effect of cold upon fiber plants, and some interesting facts have been demonstrated. Regarding the effect of the February storm upon ramie in Louisiana, Mr. S. B. Allison writes as follows:

> The heavy snow that began falling February 14 and continued until February 16, at which time the thermometer reached from 15° to 18° below freezing, did not injure the stand of ramie in the least, and I have a letter from Mr. F. Natho, of Texas, stating the same facts. I returned yesterday from a visit to Captain Willet's field, and find his ramie in fine condition. Half of my ramie at the present time will average 12 inches; Captain Willet's, on a sandy land, will average 18 inches, and on his black land about the same as mine.

From this it will appear that the plants in southern sections will stand a considerable degree of cold for a short period, although they will not stand the continued cold of a more northern winter climate. In the grounds of the Department of Agriculture they are among the first plants to show the effect of the late fall frosts, although the roots covered with manure survived the severe cold of the past winter.

The Bœhmerias are an extensive genus, some fourteen species being recognized in India, many of which produce fiber of greater or less value. *B. macrophylla* is particularly mentioned as yielding a fiber much prized in Nepal for fishing nets, and *B. malabarica* is used for the same purpose in Ceylon. *B. platyphylla*, var. *hamiltonia*, produces a fiber adapted to the manufacture of strong cordage. *B. candicans* and *B. tenacissima*, which, by some writers, have been regarded as distinct species, but which are given as varieties of *B. nivea* in the Dictionary of the Economic Products of India, will not be considered in the present work, *B. nivea* being of chief importance as furnishing the ramie or China grass, of commerce.

COMMERCIAL USES.

The fiber of ramie is strong and durable, is of all fibers least affected by moisture, and from these characteristics must take first rank in value as a textile substance. It has three times the strength of Rus-

sian hemp, while its filaments can be separated almost to the fineness of silk. In manufacture it has been spun on various forms of textile machinery, also used in connection with cotton, wool, and silk, and can be employed as a substitute in certain forms of manufacture for all of these textiles and for flax also, where elasticity is not essential. It likewise produces superior paper, the fineness and close texture of its pulp making it a most valuable bank-note paper. In England, France, Germany, Austria, and in our own country to an experimental extent, the fiber has also been woven into a great variety of fabrics, covering the widest range of uses, such as lace, lace curtains, handkerchiefs, cloth, or white goods resembling fine linen, dress goods, napkins, table damask, table covers, bedspreads, drapery for curtains or lambrequins, plush, and even carpets and fabrics suitable for clothing. The fiber can be dyed in all desirable shades or colors, some examples having the luster and brilliancy of silk. In China and Japan the fiber is extracted by hand labor; it is not only manufactured into cordage, fish lines, nets, and similar coarse manufactures, but woven into the finest and most beautiful of fabrics.

The specific gravity of ramie yarn is less than that of linen yarn in the ratio of 6 to 10, so that 1 kilogram linen yarn No. 10 measures 6,000 meters, while the same weight of ramie yarn measures 10,000 meters. This peculiarity lessens the apparent difference in the price of the two yarns. On the other hand, ramie yarn is heavier than cotton in the ratio of 6 to 5. Ramie yarn is easily distinguishable from other yarns by its high luster and silky appearance, in which it excels linen and cotton; ramie fibers are distinguished from all other fibers by their great length, usually from 10 to 15 centimeters (often 25 to 40 centimeters and more), by a certain straightness and stiffness, and by the considerable breadth of from 0.04 to 0.06 millimeters (flax 0.016, cotton 0.014 to 0.024, silk 0.009 to 0.029). (*Dr. Hassack.*)

FOREIGN CULTURE.

China is at present the source of supply of the raw product. The plant is cultivated almost exclusively in the basin of the Yangtze River, central China. Kiangsi, Hupeh, and Szechuen, provinces lying between 30° N. latitude and 100° and 115° E. longitude, are the principal districts. Hankow and Kiukiang are the shipping ports.

CULTIVATION IN CHINA.

Regarding Chinese practice, United States Consul H. W. Andrews makes the following statements:

The soil on which it is grown is red clay, with sand mixed in. The means of propagation with the Chinese is to dig up the roots in the fall, separate them in small bunches, and replant. The plants are cut three times each year—in May, August, and October. The first crop is longer in fiber and better in quality than the latter two. The preparing of the plant is all done by hand labor by the farmer. After cutting, it is put into water and rotted—same treatment as with hemp; then it is beaten with a flail and broken, the bark being carried off with water.

From this point there are two processes of working. The light-colored grass—that is to say, the commercial forms that are used in the manufacture of grass cloth—is dried over a charcoal fire, while the darker form—used for fishing nets

and cordage—is sun dried. A medium grade is used for sewing twine, and a very crude form, sometimes exported, is the raw state of the third cutting, merely dried with the bark intact. The best fiber is not exported, being too high priced. The Chinese say the difference in color of the fiber is owing to the different locations and soils in which it is grown. This, however, the foreigners here seem to doubt; they lay it to the process of drying after the bark has been washed away, whether dried with charcoal, as in the case of the light-colored, or sun-dried, as in the darker. The yarn for weaving cloth is all prepared by hand, and they have no difficulty in working it.

According to a Chinese work published half a century ago, a light, sandy garden soil is chosen when the plants are to be propagated from seed; and when there is no garden, a piece of ground is secured near a river or a well. When the young plants are 3 inches high they are transferred to a stiffer, thoroughly prepared soil, and watered every five days during the first three or four weeks. This, at least, was the old Chinese practice. In the present day the soil usually chosen in China is a red clay "with sand mixed in," and the plantation is established with roots dug from old plats in the fall.

CULTIVATION IN INDIA.

This statement is compiled from the Dictionary of the Economic Products of India, and from No. 18, Records Government of India Revenue and Agricultural Department. The plant thrives in almost any soil, though preference should be given to rich, light, sandy loam, well worked and sufficiently shady. In the Kangra district "a rich loam suits the plants best, but they will grow in any soil, provided a full supply of moisture is available, combined with thorough drainage." In the rainy season, in swampy or retentive lands, the plants decay in a very short time. There should be a good subsoil, as the roots penetrate 12 to 14 inches in search of moisture. In dry seasons irrigation is necessary.

The best climate for profitable culture is one which will promote the greatest growth of stems, with the greatest number of annual cuttings and largest yield of fiber; in other words, a tropical (or semitropical) climate, with a moist atmosphere and fairly good rainfall. The land, if not rich, should be manured, plowed to a considerable depth, and tilled lightly to remove weeds. Furrows 3 feet apart are made to receive the cuttings or roots. In the Kangra report it is stated that the roots are set 6 inches deep at the full distance of 4 feet apart each way. This distance will give 3,000 plants to the acre. Mr. James Montgomery says:

After the first two years of cultivation the plants may well remain undisturbed for four years, hoeing well between after each crop, clearing away weeds, irrigating moderately during the dry season, and supplying manure where necessary. The only manure I had at command has been vegetable, consisting mainly of the leaves and wood portion of the plant itself, and of tree and vegetable leaves stored up for the purpose, with which I mix a considerable amount of wood ashes. With the aid of this only I have kept plants growing in the same spot for upward of six years,

but consequent on the then very crowded state of the ground the stems were short and very weak. I would therefore recommend a thorough removal after four years, the land to be then well plowed, cleaned, and manured.

George Watt recommends as the most favorable manures those that contain nitrate of soda, sea salt, and lime. Regarding the time to harvest, Mr. Watt states that experience is necessary to decide this. Care should be taken to effect the cutting before the plant becomes covered with a hard or woody bark, this being indicated by the green skin turning brown, starting at the base. The crop of cuttings may be taken if, by passing the hand down the stem of the plant, the leaves break off crisply.

CULTIVATION IN FRANCE.

Mr. Favier, who has considered every phase of the ramie industry in France, from the preparation of the ground to the manufacture of the finished fiber into the most beautiful fabrics, states that the proper lands for this culture, which must have a deep soil, are the silico-calcareous and the sandy alluvial with a permeable subsoil. "As a general rule, a soil is very favorable to the culture of ramie when the dominant element is siliceous or sandy, without being pure sand. The lighter and more friable and permeable the soil, the more productive will be the ramie." Toobe says that marshy, boggy land that is clayish, salted, or compact should be avoided. Favier considers irrigation necessary. All experiments in arid and dry land without irrigation have given no practical results. Six months before planting, the soil should be turned to a depth of 40 centimeters (or about 10 inches) that the subsoil may be subjected to the action of the atmosphere. When the soil is very mellow two or three good plowings lengthwise and crosswise should suffice, to be performed two months before the roots are planted.

The planting in Egypt, Algeria, and Spain is done from the end of October to April. In France the most suitable time is from March to the middle of May. Mr. Favier says:

> The leveling being well established, there are traced furrows about 15 centimeters in depth and 20 centimeters wide, with a space of 70 centimeters between.[1] In these furrows the plants are placed upright against the slope of the furrow on the south side by preference, and 30 centimeters apart, alternating with the adjoining rows, and then they are covered so as to leave their tops level with the ground, or lightly covered to about 1 or 2 centimeters in depth, if there is fear of late frost. The earth which serves for covering is taken from the side of the furrow by scooping out the irrigating trench. We intend by this alternating to establish a plantation in the quincuncial form, each plant being placed opposite on an open space in the next line. The plantation is thus arranged in ridges, or "billows," and channels. A "billow," in agricultural parlance, is a strip of earth raised between two trenches or channels.

RAMIE CULTURE IN THE UNITED STATES.

Assuming that it is time to interest ourselves in culture, if it be only experimental culture, a knowledge of all the conditions of successful

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[1] Equivalent to rows about 27 inches apart, with the plants nearly 1 foot apart in the row.

growth is essential in order to make the right start. Until the ramie grower has acquired experience of his own, he must necessarily be guided by the experience of others, and as too much of the past American literature of the ramie question has been misleading, because the ground has been indifferently covered, and the writers on the subject have too often shown carelessness in their deductions, the writer will endeavor, in the pages which follow, to confine himself to facts. And these facts will be presented in the form of brief statements based upon the actual results of intelligent experiment, not only in our own country but in different portions of the globe where ramie has been seriously studied.

SOIL AND CLIMATE.

In general terms it may be said that the ramie plant requires a hot, moist climate, with no extremes of temperature, and a naturally rich, damp, but never a wet, soil, the necessary moisture to be supplied by frequent rains or by irrigation; in other words, such a climate and soil that, when the growing season has commenced, the growth will be rapid and continuous. In the United States the best localities, so far as experiment has determined, are portions of Florida, Mississippi, Louisiana, and Texas, on the Gulf, and central California, on the Pacific Coast. The other Gulf States, doubtless, will prove equally favorable to this culture when more extensive experiments have been undertaken than are now recorded. Regarding the northern limit of commercial culture it is difficult to make positive statements. The plant thrives in South Carolina, and it is fair to suppose that two annual crops are possible, though the quality and yield of the fiber can only be ascertained to a certainty by careful tests of the product of both crops.

In the Gulf States ramie has been grown experimentally in a great variety of soils, from the light sandy uplands to the rich black lands of the Louisiana bottoms, though light, sandy, alluvial soils have always given the best results. In California deep alluvial, sandy, or loamy lands which, when well prepared, will hold their moisture through the growing season, or that can be irrigated, are most commonly selected. Any good soil that will produce other crops is recommended, particularly if well prepared, or that holds its moisture through the growing season, or which can be irrigated. Dr. Hilgard, director of the California Agricultural Experiment Station, says:

> It is hardly necessary to remind any intelligent farmer that only strong soils can be expected to produce in one season one crop of 10 tons of stalks of any kind, and that few can continue to produce such crops for many years without substantial returns to the land, no matter how fertile originally. Among the strongest soils in the State are those containing more or less of "alkali," and as these are mostly valley lands, the question of their adaptation to ramie culture is important. Experiments have shown that, while ramie is a little more sensitive to alkali, it will stand all but the strongest spots, provided the alkali is not of the "black" kind, viz, carbonate of soda. The main reason why ramie will grow in alkali ground is the same as in the case of alfalfa—because it shades the ground, and hence the evaporation, going on through the leaves of the plants instead of at the surface of the soil, will not accumulate the noxious salts around the root crowns so as to corrode them.

ENRICHING THE SOIL.

In all countries where ramie has been grown commercially or experimentally the necessity for heavily enriching the soil by the application of the farm manures or chemical fertilizers is emphasized, for successful ramie culture is an impossibility on impoverished land.

Mr. Forbes Watson's researches in this direction have been exhaustive, and he considers that the importance attached by the Chinese to careful manuring of the crop is explained by the large quantity of mineral matters contained in the stems, and that ramie is an exhaustive crop he proves by the following analysis. In 100 parts the stems were found to have the following composition:

Composition of stems of ramie.

	Per cent.
Carbon	47.28
Hydrogen	6.26
Nitrogen	.09
Oxygen	42.23
Ash	4.14
Total	100.00

Composition of ash of ramie.

	Per cent.
Alkalies:	
Potash	32.37
Soda	16.39
Lime	8.40
Magnesia	5.39
Peroxide of iron	
Chloride of sodium	9.13
Phosphoric acid	9.61
Sulphuric acid	3.11
Carbonic acid	8.90
Silicic acid (with a little charcoal and sand)	6.60
Total	99.90

It will be noticed that the alkalies contribute almost one-half and the phosphoric acid about one-tenth of the ash. If the weight of dry stems obtained at one crop be taken at only 1,000 pounds per acre, this gives, with three crops in the year, a yield of about 3,000 pounds of dry stems per acre per annum. The quantity of ash in that quantity will amount, according to the foregoing analysis, to 124 pounds, and the quantity of alkalies subtracted from one acre in the course of the year will be about 60 pounds and of phosphoric acid about 12 pounds. In England a crop of wheat is usually assumed to subtract from the soil about 30 pounds of alkalies and 28 pounds of phosphoric acid, and a crop of flax about 50 pounds of alkalies and 24 pounds of phosphoric acid. In comparison with these numbers, it seems that ramie requires a very large amount of alkalies, especially of potash, more than either flax or wheat, while the quantity of phosphoric acid is only one-half of that contained in a crop of flax, owing to the large quantities of phosphoric acid contained in the linseed.

Where it is difficult to obtain sufficient quantities of manure it is recommended to collect and burn all refuse of decortication, and return the ashes to the soil. The proportion of mineral constituents found in

the fiber, which is taken away, is very small. The French writers attach great importance to the use of leaves as fertilizing material, and as these amount to almost half of the green weight of the crop, the advantage of such a practice will be readily appreciated.

Favier says emphatically that with utilizing the leaves a less quantity of fertilizer is necessary, "but the leaves must be regularly applied nevertheless."

In a Chinese treatise on agriculture, according to Royle, it is stated that the young plants when only a few inches high are watered with a mixture of equal quantities of water and liquid manure. After the tenth month the plants must be covered with fresh horse, ass, or cow manure; and in the tenth month of every year, before cutting the offsets which pass beyond the roots, the earth is covered with a thick layer of cow or horse manure. The use of pigs' dung, however, is to be avoided. In the second month the manure is raked off, in order to allow the new plants to come up freely.

In Mr. Favier's admirable treatise on ramie, a great deal is said upon this subject, and many interesting tables of analyses are presented. We learn that well-decomposed stable manures and well-ground chemical fertilizers, guano, and oil cake, are all used with success upon French ramie plantations. The practice is to spread these upon the land, the rains or irrigation carrying the nutritive elements where they can be readily assimilated by the plants. Reducing to pounds and acres (as the figures are given in kilograms and hectares) we find that about 7,000 pounds of stable manure, or 525 to 615 pounds of chemical fertilizers or oil cake, are used per acre.

The exact proportion of the fertilizing elements to be employed in the composition of chemical fertilizers is certainly difficult to determine, since it varies with the kinds of soil, but we may adopt a formula based upon the average of the analyses of the crops. The chemical fertilizer composed as follows, and applied in the quantities stated above, per cutting, will give satisfactory results: 3 to 4 per cent of soluble phosphoric acid, 8 to 10 per cent of pure potash, 5 to 6 per cent of nitrogen, and 8 to 10 per cent of lime.

It should be particularly noted that the quantities of fertilizers recommended per acre are to be applied per cutting and not annually. Mr. Favier considers stable manure an excellent fertilizer, as it contains very nearly the kind of nutriment that the plant requires. The fertilizer that has given the best results is oil cake, to which has been added carbonate of potash in the proportion of 10 to 15 parts of the latter to 100 parts of the former. The oil cake supplies the necessary nitrogen and phosphoric acid, but lacks the potash. The restoring of the leaves to the soil supplies a portion of the potash needed by the plant, and when this is not done, a larger proportion of potash than is indicated above should be used. The practice is to bury the leaves in trenches immediately after each cutting.

Professor Hilgard, who has treated this subject exhaustively in Bulletin No. 94 of the California Agricultural Experiment Station, makes

the statement that of all fiber plants ramie stands first as regards the depletion of the soil of plant food. A very interesting comparative table is given, showing amount, in pounds, of soil ingredients withdrawn from one acre by various fiber and other crops. The portion referring to ramie is here reproduced, and may be studied with interest and profit.

Soil ingredients (in pounds) withdrawn from one acre by a crop of ramie.

Soil ingredients.	Leaves (4.25 tons).	Stalks (7.25 tons).	Bark (2.75 tons).	Whole plant (14.25 tons).
Potash	68.13	155.99	27.86	251.98
Soda	8.99	33.63	7.52	50.14
Lime	566.91	71.77	19.14	657.82
Magnesia	114.58	43.68	10.10	168.27
Br. ox. of manganese	1.92	1.45	.20	3.57
Iron and alumina	38.56	12.16	.71	51.43
Phosphoric acid	77.13	67.71	10.86	155.70
Sulphuric acid	30.86	14.53	3.17	48.56
Silica	692.71	7.06	4.48	704.25
Chlorine	41.56	2.50	7.79	51.85
Total ash constituents	1,641.35	410.48	91.74	2,133.57
Nitrogen	206.10	105.85	57.75	369.70

The total amount of mineral ingredients withdrawn by a single crop (four cuts) is 2,143 pounds, which must be considered as permanently removed when neither the leaves nor the stalks are used as fertilizing materials. The draft per acre made on lime is about 658 pounds; on potash, 252 pounds; phosphoric acid, 156 pounds, and on nitrogen to the extent of 370 pounds. Of the potash about three-fifths, or 156 pounds, is contained in the stalks, more than one-quarter, or 68 pounds, in the leaves, while the bark and fiber, the only production aimed at, contains a little above one-tenth, or 28 pounds, of the total amount.

The leaves contain nearly 87 per cent of the total lime taken from the soil, that found in the stalks being about 10 per cent, and that in the bark 3 per cent. Of the total phosphoric acid withdrawn, the leaves absorb almost 50 per cent, or 77 pounds; the stalks 43 per cent, or about 68 pounds, while only 7 per cent, or 10.86 pounds, is found in the bark. The depletion of the soil in nitrogen is greatest through the leaves, which have more than 55 per cent of the total, or 206 pounds; about 29 per cent, or 106 pounds, is found in the stalks, while in the bark there is only 15 per cent, or about 58 pounds. It will thus be seen how very small is the proportion of plant food withdrawn by the bark and fiber as compared with that by the leaves and stalks.

If the leaves and stalks are returned to the soil, the amount of mineral matter withdrawn per acre is, comparatively speaking, very small, being only about 28 pounds of potash, 19 of lime, 11 of phosphoric acid, and 58 pounds of nitrogen. A strong soil could withstand such a small demand for a considerable length of time without showing an appreciable diminution of crops; and whenever fertilizing becomes necessary, it will probably be found that, in California, phosphoric acid and nitrogen are the substances to be supplied.

Should the stalks not be used as fertilizer, the amount of potash permanently removed from the soil would be increased by 156 pounds, that of lime 72, phosphoric acid by 68, and that of nitrogen by 106

pounds; quantities forming, with exception of lime, a large percentage of the total mineral matter withdrawn.

Mr. S. B. Allison recommends as a good fertilizer for ramie 300 pounds of cotton-seed meal and 300 pounds of kainit, and suggests mixing with an equal weight of charcoal dust; the special advantage in the use of the last-named substance, however, is not clear. The kainit supplies the needed potash, while the necessary nitrogen and phosphoric acid is supplied by the cotton-seed meal. Professor Stubbs recommends two parts of cotton-seed meal and one part of acid phosphate, at the rate of 400 to 450 pounds per acre, though he states that the results of his operations the past season lead him to believe that the fertilizer was not applied in just the right combination for the best success. In Florida the natural phosphate of the State may be used with good results, though the necessary potash will need to be supplied. Frederick Natho, in his Texas experiments, has only used "potash salts at the rate of one ton per acre per year." He supplies it, proportionately, after each cutting.

But enough has been written to enable any planter or experimenter to properly enrich his land for this crop. That the plant can not be grown successfully without bringing the soil up to the proper fertility is satisfactorily proved by the evidence set forth, and those who try to cheat the land by halfway measures, in the matter of applying fertilizers and in returning the trash to the soil, will in the end only cheat themselves.

SOIL PREPARATION.

In preparing the land for a plantation, thorough tilth—that is, deep plowing and cross harrowing—is essential, which should be done in the fall. The ground is frequently broken to a depth of 15 inches or more, but never less than a depth of 12 inches to secure good results; and lumpy land is rolled. Before planting, the ground is again cross-plowed, harrowed, and rolled—about the 1st of February being a good time for the work.

The plant is propagated by seeds, by cuttings, or by layers, and by division of the roots. When produced from seed, the greatest care is taken with the planting, as the seed is very small. For this reason open-air planting can hardly be relied upon, plants started in the hot-bed giving the best results. After planting, the seeds are covered thinly with sifted earth and kept shaded

FIG. 1.—Planting roots before subdivision.

from the sun until the young plants are 2 or 3 inches high, when sunlight is gradually admitted to them. In five or six weeks they will be strong enough to transplant to the field. Layering is little practiced in this country (see remarks on the subject of planting, p. 22. By far the most practical method and the one which will give the best results is propagation by a division of the roots of old or fully matured plants. The old plants are better than young ones for the purpose, as the root mass is larger and the roots stronger. The accompanying figures were made from a root 2 years old, which will illustrate the subject better perhaps than could be done with a larger and more mature root mass. Figure 1 shows the planting roots before subdivision; figure 2 shows the same roots with the crown roots or tubers, which are not provided with eyes (and which therefore would not grow if planted), their office seeming to be to support the life of the plant. It is said that if these crown roots are broken, as sometimes occurs from the cracking of the soil, the plant will at once give evidence of the injury.

FIG. 2.—Showing crown roots.

The planting roots are usually subdivided into lengths of 3 to 5 inches, each piece showing several eyes. Five inches is the better length to plant, although shorter pieces are often used. In this connection it may be noted that the price of 1,000 roots will be found an uncertain quantity, unless the length of root is ascertained. It would seem therefore that the most satisfactory course would be to sell the roots by weight or by some standard of measure. Ramie roots are often sold in Louisiana by the sack of 3 bushels, and 400 sacks, or 2 car loads, of roots have been taken from an acre. As to price of roots sold in this way it is learned that $3 per sack is considered a fair quotation.

PLANTING THE ROOTS.

There is the widest difference of opinion as to the distances apart the plants should be set. The foreign practice has been dilated upon at length on a former page, and it is not necessary to repeat it. Professor Stubbs formerly advocated planting in rows 4 or 5 feet apart and 1 foot in the row, but in his recent experiment the plants were set out in the row much more closely. While this will give good results in the first year, it will prove a drawback in the end, as in two or three years the mass of roots will have become solid, and require resetting to produce suitable stalks for the machine. Mr. Allison plants in rows 4½

feet apart and 1 foot in the row. Mr. Natho, a Texas grower, prefers the rows to be 4 feet apart, the plants to be set 15 inches in the row. In California the rows are often set closer than 4 feet.

Mr. Allison's practice has been to prepare the land in the fall by using a subsoil plow. About the 1st of February it is cross plowed and well harrowed. A month later it is laid up in flat beds 4½ feet from centers, leaving about 6 inches elevation in center of bed. The ground is then barred off and opened to the depth of 4 inches with a scooter plow, the roots being placed about a foot apart in the row and then covered with two furrows. A week later, when the roots are sprouting nicely, a harrow with a board at the back of it is run over the ground, which allows the young plants to come up in clean mellow soil.

Just as this report is being submitted for publication the Department is in receipt of a communication from the Perseverance Fiber Company, through Mr. W. H. Parmenter, of Houston, Tex., giving the practice recommended by the company for this season's planting. It is advocated to set the roots diagonally, as represented by * in the accompanying plan (fig. 3). Plow in the trenches, pulverizing the soil and loosening the spreading roots. The roots should not be cut off until fall or spring, unless too prolific. Irrigate in the trenches. Plant 8,000 roots to the acre. A 4-foot passageway should be left in every block of 2 acres or so.

48 inches.

::TRENCH::

18 inches.

......*..........*..........*..........*..........*..........*..........*..........*

18 inches.

....................*..........*..........*..........*..........*..........*......

18 inches.

::TRENCH::

18 inches.

......*..........*..........*..........*..........*..........*..........*..........*

18 inches.

....................*..........*..........*..........*..........*..........*......

18 inches.

::TRENCH::

FIG. 3.—Texas method of setting ramie roots.

This is similar to the quincuncial method of setting roots recommended by Mr. Favier and before referred to. Mr. Parmenter says:

In severe cold weather the plants should be protected, as are strawberry-plants, by a 3-inch covering of hay or straw. In breaking new soil plow 2 inches, then go over the land with a sod cutter twice, and then plow again as deeply as possible before setting the roots. On land already cultivated plow deeply and pulverize the soil thoroughly. After the plant attains a height of 2 feet it will require no further attention, as the roots will spread and cover so as to prevent weeds or other growth. In harvesting, a horse reaper can be utilized to advantage, and the stalks should be fed to the decorticator as soon as cut. Six hundred pounds of fiber should result from each cutting. The roots do not require replanting, but once in four years should be reset. Alluvial soil is very desirable for planting ramie. It thrives in good sandy loam. The better the soil, the finer the fiber and the greater the crop. Moisture in the soil is essential. The time for harvesting the crop is when the stalk, 6 inches from the bottom, turns brown.

Reference has been made to layering. This is usually resorted to when a supply of roots is difficult to be obtained, and it is desired to reproduce plants as rapidly as possible. It is always practiced in connection with established plantations. In California layering is practiced as follows:

The roots are planted in the first year for the special purpose of propagation, 3 or 4 feet apart, set slantingly, 2 or 3 inches of earth covering the tops. Careful cultivation is given, the ground being kept clean and loose. When the first stalks have attained the height of about 3 feet they are ready for layering. The ground should then be thoroughly moistened and the stalks bent gently down, fastened with small crotchets, and covered with 3 or 4 inches of earth, leaving the top of the layered branch uncovered. Care should be taken to avoid detaching the stalks from the parent root. In the course of three or four weeks the layers will have made stalks which can again be layered for the same purpose, and quite a number of plants can be dug out for transplanting in order to increase the plantation.

It is also suggested to plant cuttings. These are prepared by dividing the stalk into lengths of 5 to 6 inches. They are set out obliquely, and nearly covered, and if the work is done before hot weather begins they will require neither watering nor shading, but must be kept clean of weeds. In two weeks they may be transplanted.

In time the entire space between rows will have become so filled with roots that replanting will be necessary. Some have advocated the plowing up of a field of ramie when the roots become overcrowded, leveling off the ground and removing all exposed roots, leaving the field to start up anew from the roots that remain buried in the soil. This is a shiftless method at best, as it is impossible under such conditions to secure an even stand over the field, and an even growth of stalks is equally impossible. A course recommended both in California and in Louisiana is to run between the rows with a plow having a sharp rolling cutter, by means of which the superfluous roots are removed, and the rows or beds trimmed to a given width. The method advocated is to turn from one side only, allowing the roots to spread on the other side. This removes annually all old growth, and keeps the stand of plants hardy and vigorous. The course recommended in India, on the con-

RAMIE—STALKS READY FOR CUTTING.

RAMIE—STALKS SHOWING SECOND GROWTH.

trary, is to replant the entire field every four or five years in order to keep up a vigorous growth that will give a profitable yield.

The matter of securing an even growth of stalks is a very important consideration; and by even growth not only is meant even length and size of stalks, but uniformity of growth in the individual stalk. A stem of ramie either grows rapidly and rankly, when there is an excess of moisture, or it is stunted and of slow growth when opposite conditions prevail. When one of these conditions follows the other in the same growing crop, the fiber is adversely affected, for in the after processes to fit it for spinning, treatment necessary to reduce the hard or stunted growth to the condition of spinnable fiber may wholly disintegrate the structure of the fiber in the softer or free grown portion of the stalk, and great wastage and loss ensue. Or, the stalks in one part of the field may produce one grade of fiber and those on another portion a different grade; or the crops from two cuttings may differ in the same way. It will readily be seen, therefore, that when the cultivation has been carelessly conducted, and the stalks are not only uneven in quality in themselves but uneven in different parts of the field (owing to different conditions of moisture and soil fertility), that the loss in value may be sufficient to consume the farmer's profits. The only after-cultivation necessary is to plow, or hoe between the rows, as may be necessary to keep the soil free from weeds or in good condition. This work is usually performed in the spring or early summer months.

As to the operations in the second year, the detailed account of Mr. Allison's experience will give a hint as to the practice that should be followed. Early in April, when the danger of frost had passed, all young growth was cut off, but not saved. Fertilizers were applied, and the soil between the rows plowed and hoed. About the 1st of July the first crop was cut, followed by another plowing and hoeing. The stalks were then allowed to grow until about November 1, the time of the second cutting. It would be better, however, not to delay the last cut too late, in order to avoid a "second growth," which takes the form of clusters of leaves, eventually producing branches, and which appear at the point of juncture of the leaf and stalk after the old leaves have fallen. The accompanying figures illustrate this: Plate II, the stalks and growth of alternate leaves; Plate III, with the beginning of a new growth of leaves at the point of contact of the old leaf with the stalk. Figure 4 illustrates the clusters of flower racemes at the summit of the stalks, these finally maturing seed.

IRRIGATION.

In portions of Texas and California the practice of irrigation will be necessary to secure any results. But there is no doubt that in other States there are localities, not known as irrigation districts, where water must be used to produce a proper growth of stalks. While the roots can

not live in a wet, cold soil, they do require a sufficiency of moisture to insure continuous and rapid growth, and this will necessitate the practice of irrigation on any lands that may in a dry season, or in the dryer portions of every season, lack the proper degree of moisture to make satisfactory growth. On the other hand, continued cold, rainy weather, giving an excess of moisture, may injure the crop by stunting the growth.

FIG. 4.— Clusters of flower racemes.

In an official report made in 1881 by Dr. King, superintendent of the botanical gardens of Calcutta, artificial irrigation is considered essential to obviate the natural effects of a dry climate. And it is pointed out that the plants need moist air—no long, dry, hot months—a naturally rich soil, plenty of rain, and no extremes of temperature. The conclusions drawn are that in localities where these conditions are not found, or where the existing conditions can not be modified to approach them, it is useless to try to grow ramie. In the Kangra district of India the plant can not be successfully cultivated without irrigation, and the facilities for obtaining an ample supply of water at all seasons (the dry, particularly) render this district particularly favorable to the culture. Mr. Favier, in his account of French culture, has a special chapter on irrigation, urging the practice as essential to success when the proper conditions of moisture do not exist naturally.

COST OF RAMIE CULTIVATION.

Regarding the expense of establishing and maintaining a field of ramie, especially in the United States, it is difficult to make authoritative statements. Much that has been published relating to our own country is merest estimate, the figures having been based upon the experience of the cultivator, or experimenter, with small plats, which must prove misleading; even where acres have been grown instead of rods square, estimates of cost are more frequently published than figures of actual practice. And as often, the figures relating to other countries have been given without a hint regarding their source.

In considering this question, therefore, an effort has been made to give as reliable figures as can be obtained from foreign sources, and to sift carefully the published statements which refer to our own country, supplementing this data with figures secured from careful and responsible experimenters by recent special investigations.

FRENCH EXPERIENCE.

The close system of planting recommended by Mr. Favier requires 14,000 to 16,000 plants to the acre. He remarks that the expense of this number of plants, even at 30 francs ($6) per thousand, might turn many agriculturists from going into culture, and he therefore recommends purchasing a few thousand roots to make a beginning, gradually extending cultivation as the roots are multiplied. He states that the planting of 3,000 roots in March will insure by October a sufficient number of divisions of roots to plant one hectare (2½ acres), and instances a growth of 250 stalks in good soil from a single original root in three years. While this method of stocking a plantation by propagating takes time it has the merit of economy. Here is the account of the first year's operations, for a hectare, the figures in the last column having been reduced to American money, and the equivalent of an acre:

Practice.	Per hectare.	Per acre.
	Francs.	
Plowing, 40 to 50 centimeters deep, 4 horses, 2 men 3 days, at 21 francs	63	$5.04
Cross plowing, 1 horse, 1 man 3 days, at 7 francs	21	1.68
Harrowing, 1 horse, 1 man 2 days, at 7 francs	14	1.12
Fertilizers and hand labor	180	14.40
Setting out 40,000 plants:		
10 days' work for a man, at 3 francs	30	2.40
10 days' work for a woman, at 1½ francs	15	1.20
Second cultivation, 40 days' work for a man, at 3 francs	120	9.60
Weeding, 40 days' work for a woman, at 1½ francs	60	4.80
Expense of irrigation, 20 days' work for a man, at 3 francs	60	4.80
Total	563	45.04

NOTE.—Ten days' work per hectare would be equivalent to four days' work per acre.

In order to establish an exact account a rental estimated at 240 francs per hectare is added to the above "for best land, water rights included." This is equivalent to $19.20 per acre. The 240 francs added to the 563 francs gives a total of 803 francs per hectare, or $64.24 total per acre. The expense per hectare of maintaining the plantation, when once established, is stated as follows:

Practice.	Per hectare.	Per acre.
	Francs.	
Irrigation, 20 days for a man, at 3 francs	60	$4.80
2 cuttings, 20 days for a man, at 3 francs	60	4.80
Drying and putting into bundles, 20 days for a woman, at 1½ francs	30	2.40
Fertilizers and hand labor	180	14.40
Light second cultivating and weeding, reduced to 40 days for a woman at 1½ francs, or 8 days of light plowing	60	4.80
Total	390	31.20

The 240 francs rental per hectare is again added, with 20 francs on capital employed in planting, making a total of 650 francs per hectare, or $52 per acre. When a farmer owns the land, as is usually the case in the United States, the item of rental will not enter into the account. Ten francs per 100 kilograms is named as the price of the stalks on the farm. This is equivalent to about 91 cents per 100 pounds, or, in round numbers, $20 per ton.

EXPERIENCE IN THE UNITED STATES.

A careful study of the literature of the ramie question in this country throws little light upon this subject. Tables have been published, it is true, purporting to give the total cost of producing stalks and fiber from an acre of ground (including decortication, etc.), but they do not bear the test of analysis. In such a table the matter of agricultural operations is dismissed with the single item, "cultivation, $3;" and no hint is given as to the expense of establishing the plantation, cost of fertilizers, and of roots, or setting them out, yet such figures are used as the basis upon which to calculate the profit from growing the crop. The nearest approach to a positive statement occurs in the circular of a ramie machine company, in which the expense of establishing a plantation of 100 acres, including fertilizers, is placed at $5,000, or $50 per acre, and the cost of cultivation per pound of raw fiber, 1½ cents. On the contrary some voluminous writers on this subject have been satisfied with general statements to the effect that the plant requires almost no care and will produce its two or three crops per year almost without cultivation.

Mr. Fremery states that the yearly expense for cultivation and fertilizing (presumably in Texas) will amount to $20, cost of establishing the plantation not given. Mr. Frederick Natho, of Clear Creek, Tex., in response to an inquiry from the Department, gives the cost of establishing a plantation, per acre, as follows:

Preparation of the land, plowing, etc	$3.50
Fertilizing (not stated)	
Planting 8,000 roots	8.00
Cultivation first year	10.00
Irrigation (not stated)	
Total	21.50

Cultivation the second year will cost $5 per acre; cost of cutting first growth (worthless for fiber), $1; cost of cutting after first year, with mower, $1; by hand, $1.50 per acre. The cost of roots is estimated at $4 to $5 per thousand. Mr. Natho states that with irrigation four annual crops can be grown in Texas.

Regarding the figures of the Louisiana Experiment Station, it should be stated at the outset that the Louisiana experiments have been conducted on a small scale, and the estimated cost has therefore been greater than would be the case with the cultivation of large areas. They are as follows:

Preparation, two plowings, harrowing, etc	$5.00
Fertilizers (not stated)	
Setting out 8,000 roots	10.00
Cultivation the first year	5.00
Total	20.00

In preparing the land it is first broken with a 4 horse plow, then followed with a 2-horse plow. In the first year's cultivation only

improved implements (no plows) are employed. Estimated cost of cutting per acre, $1. Subsequent cultivation (after first year) is stated at $6 per acre.

The estimates of the Mississippi Experiment Station are also based on experience with small areas. These figures are as follows:

Plowing, subsoiling, and harrowing	$1.60
Fertilizers	6.00
Making rows and planting roots	8.20
Cultivating three times and hoeing twice	3.50
Total	19.30

Cultivation the second year (and subsequently), $2.50; fertilizers, $6; cost of cutting not given.

Mr. S. B. Allison, of New Orleans, responds to the circular letter of the Department with the following figures per acre from actual experience:

Nov. 1, 1890.	Plowing and subsoiling	$2.00
Feb. 1, 1891.	Running rows 5 feet from centers	1.25
Feb. 1, 1891.	Harrowing	.50
Feb. 20, 1891.	Planted roots, two hands	1.25
Feb. 20, 1891.	Planted roots, two hands	1.50
Feb. 20, 1891.	One team opening and covering	1.25
Apr. 15, 1891.	Thorough plowing	1.25
Apr. 15, 1891.	Hoeing	.60
May 10, 1891.	Plowing	1.25
May 10, 1891.	Hoeing and layering new branches	1.80
Fertilizers cost		12.00
Total		24.65

Cultivation the second year cost $3.50; fertilizers, $12, or a total of $15.50; irrigation not mentioned. Mr. Allison's land was poor, which will account for the large expense for fertilizers. On land in good fertility this expense would have been materially lessened. Mr. Allison's account of the second year's operations is so detailed that it is reproduced in full.

April 3, crop cut off after frost (not saved); plowing, barring, and throwing back the soil; plowing, $1.50; hoeing, 50 cents; fertilizers, $12. July 4, cut the first crop; quantity of dry decorticated fiber, 608 pounds. Plowing again in July, at a cost of $1; one hoeing, 50 cents. Cut second crop November 10; quantity of dry decorticated fiber, 826 pounds.

This shows a total yield of 1,434 pounds of fiber from two crops. The expenses of cultivation for the third year, 1893, were the same as the second year, and a yield of 1,626 pounds of fiber is reported.

The cost of roots varies. Mr. Allison paid $30 for the six barrels of roots per acre used on his plantation. Mr. Frederick Natho says $4 to $5 per thousand, or $35 to $40 per acre for roots.

FIGURES OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

An estimate of the total cost of establishing a ramie plantation, per acre, in the Gulf States, based on the Department's returns, is as follows:

Preparation of the land	$3.03
Fertilizers	9.00
8,000 roots	35.00
Planting roots	8.00
Culture first year	5.85
Irrigation	
Total	60.88

This allows $35 per acre for roots and $9 for fertilizers. By using the leaves and trash, after cutting, the expense of fertilizer the second year will be considerably reduced, and the plantation may be extended from the root growth of the first year at the cost of digging and subdividing. By proceeding in this manner, extending the plantings over two or three years, the cost of establishing the entire plantation would fall considerably below the figures given. The average cost of cultivation the second year is shown by the returns to be $4.25, the expense of fertilizers not included.

The only California figures that I have been able to obtain are as follows: Cost of plowing, etc., $1.50 to $3 per acre; setting out plants, 50 to 75 cents per thousand. Cost of cultivation the first year, $1.50 per day, working about three acres per day. Cost of cultivation the second year, the same, but subsequently about one-third less. Nothing is said as to cost of fertilizers or of irrigation. Cost of roots, $15 to $20 per thousand.

It should be remarked that the cost of roots will not amount to $35 per acre if layering is practiced, though it will require a little longer time to establish the plantation. In a recent publication Mr. Allison places the cost of fertilizers at $6 per acre.

HARVESTING RAMIE.

In general terms the crop is ready for cutting when the leaves can be readily detached by passing the hand down the stems, and when the bases of the stalks have begun to turn brown. The sprouting of the buds at the base of the stem is another indication. No rule as to dates can be laid down, as temperature and climatic conditions vary so greatly in different sections, and in the same section in different years. In France the first crop is cut from June to July and the second from September to October.

It is a question whether we can economically harvest in this country by hand cutting, especially if the stalks are stripped of their leaves in the field. Then, too, the system of decortication to be employed, whether the green or the dry, will need to be considered. Mr. Kauffman states that the harvesting can be readily done by reaping machines or self-

binders, which will reduce the expense to the minimum. If this mode is adopted without stripping the leaves the decortication must follow immediately, for the mass of stalks and leaves will soon heat, and the stalks rapidly mold or mildew. From personal observation, at the time of the ramie trials of 1892 at New Orleans, the writer is convinced that heating may begin in twelve hours, and that the bundled stalks will show positive signs of mildew within twenty-four hours. With stripped stalks the heating will be less rapid, but even when denuded of their leaves and lying in heaps, the stalks will soon be affected to an extent that will seriously injure the fiber.

This opens at once the old question of green or dry decortication,* each system having its advantages and its disadvantages. If green decortication is employed, it is claimed that the fiber is more readily separated from the wood or waste portion; that the extra expense of drying the stalks is avoided, though the work must be done at once. If the dry system is employed, the crop can be harvested and cured more deliberately, and the stalks stored away, to be decorticated at the pleasure of the grower.

FRENCH PRACTICE.

Mr. Favier makes the following statements regarding the manner of gathering the crop in France:

The stems may be stripped of their leaves before being cut, and this operation considerably facilitates their desiccation. To effect this work the stalk is grasped with one hand at the top, over the terminal bunch of leaves, and with the other they are drawn downward to the bottom. The leaves are easily detached by the simple passage of the hand and fall upon the ground. In this manner the operation is very rapid. The expense which may attend this labor will be compensated for in the enriching of the soil and the diminishing of the quantity of fertilizers to be employed. The agriculturist can judge for himself as to the advantage of this system to his fields. The harvest should be always in a dry time, and the stalks should be cut as near to the soil as possible but not below the surface. A very sharp instrument should be used, to avoid any tearing of the main stem and to prevent breaking off pieces of the roots or parts of the lower stalk, which may easily occur with badly cut plants, much to their injury and to the detriment of the crop. We have successfully employed a curved pruning knife that was a little heavy. The stalks being cut should be spread over the ground, turned over, well dried, and then shaken to throw off the remaining leaves, and then put into bundles. This requires ten days, after which the bundles should be placed upright and left in the open air at least ten days longer before storing them away. Care must be taken not to put them away damp, because of fermentation and injury to the quality of the fiber.

The bundles of stalks should be kept in a very dry place and protected from all moisture, which might produce mustiness and render them unsalable. When they are piled up care should be taken not to pack them too closely, but to cross the bundles so as to diminish the points of contact and allow the air to circulate among them as much as possible. The most favorable places for storing them are large lofts or garrets, but if sheds must be used they must be so arranged as to protect the stalks from rain, and planks must also be placed over the ground to prevent contact with the earth.

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* See Report No. 1, Fiber Investigations Series, 1890, p. 84.

THE DRY SYSTEM OF DECORTICATION.

It is extremely doubtful if ramie stalks can be sun dried in the climate of Louisiana to a state of sufficient brittleness to work properly in the machines. Kiln drying adds to the expense, and, as some assert, hardens the resinous principle or gum which holds the filaments together in the bast, making the after separation of the fiber more difficult. The dry system of decortication, therefore, is hardly adapted to Louisiana and the Gulf States. In California, where the climatic conditions are so different from those which prevail in Louisiana, the dry system will undoubtedly give the best results. Professor Hilgard says:

It will readily be understood that the dry mode of working is best adapted to a dry climate, in which the stalks and gummy bark become so brittle that the breaking and beating is effective to a degree which it would be impossible to attain in moist climates like those of Louisiana or Guatemala except by artificial heat, which, as stated, is therefore generally used in connection with the wet process. Hence the dry mode of working promises exceptional advantages where, as in the interior of this State (California), the dryness of the summer air is proverbial. The dry process also possesses the advantage that each machine can be kept running continuously, on practically uniform material, while in the wet mode of treatment the plants must, in a large field, either be worked at very different degrees of maturity or else the crop must be attacked with a large number of machines in order to secure uniformity of the product, after which the machines will lie idle.

SELECTION OF THE STALKS.

The Chinese strip the fiber by hand, producing, it has been stated, less than 2 pounds per day per laborer. This practice admits of careful selection of the stalks, and no doubt the even quality of the China grass of commerce at the present time is due to such careful selection. It is a question, therefore, if by cutting the crop with a harvester, as has been recommended, where the stalks will be of varying lengths, even including short and immature growth, an even quality of fiber can be produced. Dr. Forbes Watson gives valuable testimony upon this point:

Some people say that the plant should be grown to the height of 6 feet; some say they should not be more than 3 feet; but the result of my experiments point to the fact that 3½ to 4 feet is about the right height to grow them. If the length is not more than 2 feet, the fiber is very fine, but the chances are you get more waste and not such a good percentage of fiber. In the long stems the fiber is not so fine as in the medium ones; in short, the medium stems, from 3 to 4 feet, are about the right length to cut. This has an important bearing upon the question of the number of crops which can be obtained. It is clear that if you allow the plant to grow 6 or 8 feet high, you can not expect to get as many crops as when only 4 feet. Moreover, there is this characteristic: All these stalks which you see here from the same plant—that is to say, the shoots—have come from the same root. Having determined the proper length, the stems should be gathered accordingly, only those being cut which have attained the right height; in this way a continuous crop may possibly be secured.

Mr. Allison urges the importance of running a mowing machine over the field after the first frost in April in order to produce an even growth,

and advocates harvesting in the latter part of June or in July, when there is actually nothing for the farm hands to do, as the sugar and cotton are both laid by and the cotton is not ready for picking; then again in the fall at any time between November 15 and December 15, when the grinding season is over and cotton picking about done with.

NECESSITY OF EVEN GROWTH OF STALKS.

So little attention has been paid to the importance of securing an even growth that this authority makes the statement, as the result of long experience and observation in the South, that there has been very little properly grown ramie, the deduction being that to harvest a ramie crop in an economical manner, without regard to the system of decortication that will follow, there must be an even growth of good straight stalks which will give a percentage of merchantable fiber that will make the culture profitable.

When the stalks are of varying lengths, the fiber must be of varying quality. In Mr. Montgomery's report, concerning his experiments in the Kangra district of India, it is even recommended to make two grades of fiber from the same stalk. He says:

I have already expressed my opinion against the use of either immature or small stems as likely to give a result inferior both in quality and quantity; yet I am fully satisfied as to the advisability of not only sorting the crop as cut, according to length of stem, when necessary, but I would further recommend that the peel from all stems of 5 feet and upward should be divided into two, and the fiber from the upper and lower portions kept distinct.

He also shows that a crop grown in the rainy season will produce a poorer (softer) quality of fiber, and in less quantity, as the resinous matters are in a more diluted state, and are subsequently washed out. In another report of the office of fiber investigation it is shown that the larger, more succulent leaves of the sisal hemp plant always yield a much smaller percentage of fiber than the more solid, normally grown leaves. It is doubtful if it would pay to sort the crop in this country, but it certainly would not pay were a large percentage of the stalks small and immature.

When the crop is not harvested with a reaper the stalks must be cut by hand. This operation has been stated to cost from $1 to $2 per acre, though even $2 is a low estimate, especially if the stalks are bundled, as they should be, for ease in handling.

ESTIMATES OF YIELD.

The estimates of yield per acre in this country have too often been overstated. In treating this subject, to get at the truth the figures of actual yield in many countries have been carefully studied, and, from the mass of positive evidence accumulated, it has been possible to secure data by which the estimates for our own country can be tested, there being very few records of actual yields, and those mainly calculated from the product of small areas.

Mr. Toobe, of New York, who bases his published estimates on French experience, states that an acre will produce 1,500 pounds of dry stalks the first year, about 3,000 pounds the second year, about 4,600 pounds the third year, and about 6,600 the fourth. He states that 1,000 kilograms of stalks per hectare will produce 200 kilograms of decorticated fiber. Reducing the above yield of stalks to the equivalent of acres and pounds, for decorticated fiber, we have: First year, approximately, 300 pounds of fiber; second year, 600 pounds; third year, 900 pounds; and fourth year, 1,300 pounds of decorticated fiber.

RAMIE IN FRANCE.

Regarding the cultivation of ramie on French soil, Mr. Charles Roux, in treating this subject in his brochure Notice sur La Ramie, says:

> An error has, however, crept into many publications, one which has been extremely prejudicial to the development of this culture. It has been represented that ramie is successfully grown in France, but well-organized experiments have proved that this is a mistake. Ramie is essentially a plant of warm countries, and the species requiring the least heat (white ramie, or Nivea) is also peculiarly sensitive to cold.
>
> In the south of France, especially in Provence, where various small plantations have been started, they have managed to make two cuts per year, but the second cut is often of poor quality, having the fiber ill formed and wanting in strength. Neither would we advise the agriculturists of our country to enter into this culture, as the ramie plant is too sensitive to frost, and especially to cold winds. There should be no advantage, in my opinion, in the cultivation of this plant, except in those countries where at least three cuts per year can be assured—that is, in countries lying south of 40° of north latitude. The French colonies in Algeria, Tunis, Tonkin, Réunion, and Guadeloupe are admirably adapted to the production of ramie. In these countries 3 of 4 cuts a year may be relied on, giving an average yield of 30,000 kilograms of green stalks, not counting the weight of the leaves, per hectare and per cut, and this would represent a yield of 1,500 kilograms of dry ribbons per cut, or 600 kilograms of degummed filasse, at an actual value of 175 francs per 100 kilograms.

The figures, 30,000 kilograms per hectare, mean a little less than 11 tons of green stalks per cut per acre. The 1,500 kilograms of dry ribbons per hectare, equal to 1,320 pounds of dry ribbons per acre, would yield 528 pounds of degummed filasse per acre. Mr. Roux adds that no plantation of any importance is now in existence in France, and we know that the Favier company uses only Chinese fiber in its works at Valobre.

It is not believed that in this country we should expect more than 8 to 10 tons of stalks with leaves at a cutting per acre, or for two cuttings, the average in Louisiana being 20 tons. This opinion is based on the results of actual practice upon the small areas experimentally cultivated; for it can not be claimed that ramie, up to the present time, has been grown in the United States other than experimentally.

French experience, as recorded by Landtsheer, has shown that every ton of stalks and leaves, when properly treated, will give about 25 pounds of the chemically degummed fiber fit for spinning, and the records of recent experiments in Louisiana have shown very nearly the same results. This will be referred to again.

According to Hardy's experiments in Algiers, it is estimated that an acre of fully grown green stalks with their leaves will produce a weight of about 48,000 pounds, which will yield 4,900 pounds of dried stalks and 1,400 pounds of cleaned ribbons from one cutting. This, reduced to equivalents, gives a yield of 229 pounds of dried stalks to a long ton of green stalks with leaves, from which is obtained about 65 pounds of cleaned ribbons, yet to be degummed. This is equivalent to 630 pounds of ribbons from a ton of dried stalks. Professor Hilgard estimates two cuttings in California to yield 12,900 pounds of dry stalks, and that the minimum product of raw fiber from this weight of dry stalks would be about 15 per cent or, say, 1,935 pounds. This is equivalent to 336 pounds of raw fiber to the long ton of dried stalks. Both the Algerian and Californian figures represent estimates based on the yield of small areas (hardly more than garden plats) and should not be taken as absolute, compared with the figures of Favier or De Mas, where the yield per acre is actual.

YIELD FOR DIFFERENT COUNTRIES.

In the following tables are given the product of two cuttings of stalks to the acre, and the percentage of yield, for different countries—average statements. The figures represent the product of the second year's growth after planting. The third and fourth years would give a proportionately larger yield, as has been shown:

Product of two cuttings per acre, in pounds.

Country.	Green stalks.		Dry stalks.	Raw fiber.
	With leaves.	Denuded.		
Algiers (Hardy)	96,000	27,600	9,800	2,800
Italy (De Mas)	52,600	26,300	5,260	944
Italy (De Mas), third year	64,720	32,360	6,400	1,280
France (Toobe)	....	....	3,000	600
France (Favier)	....	....	6,776	1,285
India (Spon)	....	10,400	....	500
Louisiana (Kauffman)	....	22,400	....	1,000
California (Hilgard)	55,454	....	12,900	1,935

Product of one cutting per acre, and percentages of yield.

Country.	Raw fiber from one crop.	Raw fiber from one ton—green.	Per cent dry to green stalk.	Per cent fiber to dry stalks.
	Pounds.	*Pounds.*		
Algiers (Hardy)	1,400	65.0	10.2	28.9
Italy (De Mas)	472	40	10	17.9
Italy (De Mas), third year	640	44.2	9.8	20
France (Toobe)	....	....	....	20
France (Favier)	....	....	11.1	19
India (Spon)	250	62.8	....	....
Louisiana (Kauffman)	500	58.3	....	....
California (Hilgard)	*967	77.2	23.2	15

* Average, estimated.

In one instance, where the weight of green stalks with leaves was not known, the quantity has been calculated upon the ratio of 5 to 7, it having been shown that the leaves of fresh-cut plants represent five-twelfths of the entire weight. By calculating the weight of the entire plant in such instances it is possible to show, approximately, for the sake of comparison, the yield of raw fiber from a ton of green stalks with leaves in different countries.

The tables form an interesting study. The figures for France and Italy are absolute statements of yield per acre, and it is interesting to note that there is a close agreement both in the percentage of weight of dry to green stalks (about 10 per cent), and in the percentage of weight of raw fiber to dry stalks (varying from 17 to 20 per cent). From a careful study of the figures of many statements of yield throughout the world, the writer is of the opinion that 10 per cent may be fairly stated as the percentage of yield of dry to green stalks with leaves, with 20 per cent as the yield of raw fiber from a ton of dry stalks. These percentages approximate very closely to the figures calculated from the careful experiments of Rivière in Algiers, Landtsheer in France, and Allison in our own country, also agreeing, as before stated, with the figures of Favier and De Mas in the above tables.

The yield per acre of green stalks with leaves, when well grown, for a single cutting in the Southern States, has been placed at 8 to 10 tons, or say 25 tons for two cuttings under the most favorable circumstances. A calculation based on the above figures places the yield of dry fiber per acre at about 1,000 pounds, for two cuttings, which will not be found far out of the way in actual practice, when the crop is cultivated on a commercial scale, provided, always, that the crop has been properly grown.

Commenting on Mr. Hardy's figures, Mr. Favier makes the statement that such great crops have not generally been produced in France. They are certainly much higher than the figures of other countries, which relate to actual yields, unless we except Dr. Hilgard's statements of yield in California; but the high percentage of fiber to dry stalks, as calculated from Mr. Hardy's statements, can not be taken as a safe basis of estimate. And were Dr. Hilgard's figures based on the actual yield of one or more acres, instead of a plat 18 by 34 feet, no such high percentages of yield would have been recorded.

Referring again to Mr. Favier's opinion, he makes the statement that agriculturists have obtained in the south of France as high as 1,600 pounds of filament per acre. It may therefore be admitted that ramie, under conditions which may be considered normal in that country (France), will yield from 1,280 to 1,600 pounds of filament in two crops per annum, so that each cutting will yield more filament than the best annual crop of hemp or flax.

In the Bulletin of the Botanical Department of Jamaica, for March and April, 1894, an estimate of the yield of fiber per cutting per acre

is given as follows: 20,000 pounds green stalks with leaves, equal to 5,000 pounds dry stalks, yielding 15 per cent, or 750 pounds of dry fiber. These figures can not, however, be safely taken, since 84 pounds of dry fiber from a ton of green stalks and leaves is an unusual product. The figures for Algeria are excessive, but the Jamaica figures of yield per ton of green stalks with leaves show an increase of almost 30 per cent in dry fiber over the yield in Algeria, calculated from Hardy's figures.

THE POSSIBLE AMERICAN YIELD.

It will be impossible to accept some of the statements of yield in this country, because, in estimating on the basis of a given number of stalks in an acre, stalks of full length and weight have been considered, when in actual practice many of the stalks in a ramie field will be found too short and too immature to work, and the total output of raw fiber made from an acre will be minus in just the same ratio that the stalks are immature or half grown. It is to be regretted that the published statements of yield in Louisiana have not been carried out in sufficient detail to admit of subjecting them to analysis. Figures have been published from time to time during the past twenty years by ramie companies and writers, but often, when it has been possible to test them, they are found to be very wide of the mark, the estimate frequently having been based on the weight of a stalk and the number of stalks supposed to grow on an acre of ground, the yield of dry fiber per acre necessarily being very much overstated. Kauffman's statement of 10 tons of stalks for two cuttings without leaves, which is quite within bounds, while his estimate of 100 pounds of fiber from a ton of stalks without leaves (which is equivalent to 58 pounds from a ton of stalks with leaves) brings the yield of raw fiber between the figures of Hardy and De Mas, as given in the table.

Mr. Charles Rivière (director of the botanic garden at Algiers) states that 1,000 kilograms (2,200 pounds) of stalks and leaves will yield 520 kilograms (1,144 pounds) of stripped stalks; the 520 kilograms of stripped stalks will give 104 kilograms (228.8 pounds) of dry stalks, and these will yield 20.8 kilograms (45.7 pounds) of decorticated product (a little less than 20 per cent) and this weight will give 11.2 kilograms (24.6 pounds) of degummed filasse. "This is a yield which I have proven in all my experiments." (*De Landtsheer.*)

This means that a long ton of green ramie stalks with leaves will yield 46½ pounds of decorticated fiber, which will give 25 pounds of degummed fiber, the figures forming a ready basis of calculation when the total weight of an acre of stalks is known.

Professor Hilgard gives detailed figures of yield per acre, and percentage of dry to green stalks with leaves, from actual experiments at Berkeley in 1890, which form an interesting study. The following table has been arranged from these figures:

Date of cutting.	Yield per acre.		Percentage, dry to green.
	Green.	Dry.	
FIRST CROP.			
1888. July 16	34,861	9,620	27.6
1889	44,304	9,443	21.3
1890. July 9	54,173	8,662	16
1890. July 9	44,268	8,307	18.8
SECOND CROP.			
1887. October 31	12,354	....	....
1890. November 21	14,910	5,254	35.2
1890. November 21	7,204	2,698	35.2

It should be stated that the product for an acre is estimated from actual cuttings on two plats, about one seventy-first of an acre. The high rate of yield at Berkeley (compared with the yields reported in our first table) is readily accounted for by the fact that in these small plats, 18 by 34 feet, the crop was grown under the best possible conditions, and doubtless with garden culture. The figures quoted from Favier are actual yields from crops grown upon a plantation of 250 acres in the south of France.

Careful experiments with the fiber from different cuttings will be necessary before authoritative statements may be made as to the number of cuttings that may be depended upon in the United States. The point to consider is not whether two, three, or four cuttings of stalks of requisite growth may be made, but whether the fiber produced in these stalks will be of uniform quality in the different cuttings, and of the proper standard of spinnable fiber. Taking ten weeks as the average time required to mature the crop, three crops would require a growing season of thirty weeks. If the climatic conditions of the section where the crop is growing are such that the requisite degrees of heat and moisture can be kept up uniformly for a period of thirty weeks, then three crops can be readily grown. If, on the other hand, the first and third crops are of slow growth while the second crop, which has been produced in midsummer, is of rapid growth, a uniform grade of fiber in the three crops can not be produced, and two sure crops will therefore be better than one sure and two uncertain crops. In order to grow two sure crops the early spring growth should be mowed off, say from the first to the middle of April.

Professor Hilgard makes the following statement regarding the rate of growth in California:

In the Kern Valley there is little difficulty in getting four cuts of good size and quality, and the same is probably true on the stronger soils as far north as Fresno, and southward in the valley of south California. In the Sacramento Valley three cuts can doubtless be obtained, at least when irrigation is employed, or in naturally moist land. At Berkeley and elsewhere on the immediate coast, two cuts (the second usually a small one) is all that can be counted on; but in warm valleys of the Coast Range doubtless from two to three full crops, according to the supply of moisture and the strength of the soil, may be looked for.

Little may be expected from a field of ramie the first year, although when the climate admits of three annual cuttings the third cutting may give stalks fit to work, though the yield will be small. As a general rule one year of cultivation, after planting, without yield should be calculated upon.

In the opinion of the writer, therefore, two cuttings are possible in Texas and Louisiana, three in portions of Florida, and, as has been already stated by Professor Hilgard, from two to four cuttings in California.

Since the recent visit of the writer to New Orleans, at the time of the official ramie machine trials of 1894, he is convinced that two cuttings of second year's growth ramie, when properly cultivated, will produce 20 tons of green stalks with their leaves.

Measured plats of second crop Louisiana ramie, cut by Mr. Allison, when weighed showed a yield equivalent to 23,000 pounds and 25,000 pounds per acre, in round numbers, the first lot being white ramie, the second lot green ramie, and Mr. Allison is of the opinion that with good culture this yield may be maintained. This is equivalent to 20 and 22 tons of green stalks and leaves per acre annually.

After a careful study of the yields of all countries, we may fairly estimate 8 to 10 tons of stalks with leaves at a single cutting per acre, or for two cuttings, which is the average for Louisiana, 20 tons; and it may be possible under the most favorable conditions to secure a yield of even 25 tons per year.

EXTRACTING THE FIBER.

It is not important to record here the consecutive history of ramie machine invention in America, particularly as it would necessitate describing almost a score of machines that, one after another, were brought to the attention of the public for a time, only to be practically abandoned when it was proved they were unable to fulfill the claims of their inventors. Since 1867 the persevering effort to produce a satisfactory machine has naturally resulted in a gradual improvement in mechanical construction; new principles have been worked out and the causes of subsequent failures studied, with the result that substantial progress can be recorded, though economic success can hardly be claimed.

THE MACHINE PROBLEM.

What are the difficulties? A familiar illustration is here offered. When a farmer starts up his thrashing machine after harvest he feels reasonably certain that the implement is strong enough to clean his grain; that it may be run to its full capacity; that it will do its work properly, and, barring unusual accidents, run continuously without subjecting him to loss of time and other annoyances. And he knows how many bushels of grain per day it will clean, and he is able to calculate beforehand the number of days that will be required to thrash his crop.

Now suppose that this implement, after running a little while, becomes so clogged in some of its parts that thirty or forty minutes are lost in remedying the difficulty, and that after a further run there is a sudden breakage that causes him to lose the remainder of the forenoon, and this is repeated day after day. Or, that it fails to work automatically, as is expected, some of his grain not being thrashed at all, but thrown out with the straw, or the kernels broken and destroyed; or suppose, if it works without breakage or loss of time, that at the end of the day he finds the expense of thrashing alone has amounted to very nearly as much as he will receive for the thrashed product when sold, there being no other device with which to thrash the crop, and no method of hand cleaning that will not involve even greater money loss. Under such disheartening experiences how long will he cultivate grain crops? This supposed case illustrates fairly some of the difficulties which have entered into the ramie machine problem.

But this difference should be noted: The kernels of wheat are easily separated from the ear, while the fiber of ramie, inclosed as it is in a coarse, woody stalk, and hidden under a layer of outer bark, tenaciously holds its own until the entire mass has been broken, beaten, and scraped by a series of rapidly revolving mechanisms. The gummy matters which hold the filaments together in the bark often harden upon these mechanisms, particularly when of small diameter, the fiber adhering and wrapping about them, necessitating repeated stoppages. Or, sometimes, the stalks choke the feed rolls, bringing the machine to a sudden standstill; or a few stalks stick in their places, while the others are moving on, hopelessly entangling the fiber. Again, the fiber is only partially cleaned, pieces of wood coming out attached to the strands of fiber, or an inch or more of the end of the stalks are not cleaned at all. Then, in other machines the beating is so harsh that the fiber is cut and broken and its value greatly impaired. After considering the many difficulties and hindrances in the effort to turn out good fiber, the failure to produce any fiber in paying quantity has proved the greatest obstacle of all to that success for which invention has been striving so long.

TWO CLASSES OF MACHINES.

Ramie machines may be divided into two classes: (1) Delignators, or simple bark strippers, and (2) decorticators, which not only remove the bark but make some pretense of removing the outer pellicle or epidermis and the layer of cellular matter covering the fiber layer proper. The bark strippers produce the fiber in the form of flat ribbons, only the wood of the stalk being eliminated, and they are usually constructed with some form of knife or knives, with which the stalks are split before being subjected to the action of the breakers and beaters. The decorticators usually first crush the stalk by means of metal rollers, presenting the flattened mass to the action of the breaking or beating devices, and frequently there is a system of mechanisms for combing the fiber

before it is finally delivered to the aprons. The product of the delignators is always the same, a flat ribbon of bark, whether the dry or green systems of decortication have been employed. The product of the decorticators, on the other hand, is almost as variable as the machines which turn out the fiber. In some of the poorer machines this product is little more than a mangled strip of bark, neither a delignated ribbon nor decorticated fiber, but something more fit for the trash heap. In the best of them individual filaments, by the green system, somewhat resemble China grass, though darker and less clean, while by the dry system the fiber is already soft enough to spin into coarse cordage without further manipulation. Between these two extremes every quality of "ribbon" is represented.

Taking China grass, or commercial ramie, as the highest form of the fiber, since it is degummed with a loss in weight of only 15 to 30 per cent, it will readily be seen that the value of the machine-cleaned ribbons to the manufacturers must be in exact ratio to the degree to which the cleaning and freeing from gum have been carried. The simple delignated ribbon, containing all the gums, cellular matter, and epidermis, must be the lowest form of "raw fiber," as it will show the largest percentage of loss (extraneous matters) in the afterprocess of degumming, and the expense of degumming according to French experiments is shown to be in direct ratio to the bulk of foreign matters to be eliminated. This, however, will be referred to in its appropriate place further on. (See Pl. IV, showing hand-cleaned and machine-cleaned fiber.)

But we have considered that these different products, or grades of product, differ only in the degree to which the elimination of the gum and waste matters have been carried, and that the proportion of gum, cellular matter, and epidermis is the only consideration. In point of fact the product of many machines, which otherwise might be called "good fiber," has been so filled with fragments of the woody portion of the stalks, or so "chewed up" by harsh treatment, or finally so snarled and tangled in the delivery that it has had little value for any purpose. The product should be delivered straight, unsnarled and untangled, free from chips, and without breaks, cuts, or bruises, whether in the form of stripped bark or semicleaned fiber, and its value will be determined by the percentage of pure fiber it contains.

It may be fairly assumed, then, that the nearer a machine approaches in its product the ramie of commerce, Chinese hand-cleaned fiber, the higher the price of its product and the more desirable the device producing it as an economic agricultural implement.

RESULTS OF MACHINE TRIALS.

Having discussed quality of fiber produced, let us turn our attention to that other great problem, the question of quantity or output. In the first report (No. 1 of the Fiber Investigations Series) is an account of the running of five French machines several years ago, and the record

of one of the best of these machines in a field trial (in 1888) was commented upon. A single machine worked twenty-five days on the product of 1 hectare, or 2½ acres. With 20 acres, at this rate, it would have required two hundred days, and a farmer with one machine, decorticating three crops produced in a season on 100 acres, would have to run the machine ten years, of three hundred working days each, to accomplish it. To state it differently, to decorticate at this rate the product of a single cutting on 100 acres, in one month of thirty days, would require 33 machines. Yet one can imagine the French attendant of this machine who is showing it off to a novice sending three stalks through the mechanism in as many seconds, and with a complacent "Voilà, Monsieur," presenting the beautifully cleaned fiber to his delighted gaze. Such an exhibition before a capitalist who has not "read up" is sometimes worth the value of a hundred shares of stock at par. But ramie machines have improved since 1888, and it is now possible to run through the product of an acre in a day, without, however, considering the question of quality. It would doubtless prove interesting to speak of the many machines that have appeared at the official ramie trials held in this and other countries in past years, but limited space forbids. It is, however, worthy of note that in the French trials of 1889 the longest run of any machine was thirty-three minutes, and about 62 pounds of dry stalks were run through, giving a little less than 17 pounds of fiber. The longest run on green stalks was eighteen minutes, about 125 pounds of stalks being run through, producing about 40 pounds of wet ribbon. The shortest run was one and a half minutes, 15 pounds of green stalks turning out 2.2 pounds of fiber.

At the French trials of 1891 one machine ran through about three-fourths of a ton of green stalks in eighty-seven minutes, producing 475 pounds of wet ribbon.

At the New Orleans trials of 1892 one machine ran through 332 pounds of stalks in forty-two minutes, producing 88 pounds of ribbon, when it refused to work further.

At the machine trials of 1894 in New Orleans one machine ran through 500 pounds of green stalks and leaves in twenty-four minutes, giving 116½ pounds wet ribbons, and no doubt a much larger weight of product would have been recorded but for the fact that considerable fiber found its way into the trash heap through lack of proper delivery mechanisms. The other machine made as good a time record.

At the New Orleans machine trials of 1892 the machines ran on stalks that had been stripped of their leaves by hand, and no machine was able, on account of stoppages, to run through the first 500 pounds of stalks weighed out. Finally the trial was abandoned. In 1894 the machines took the stalks with their leaves, as hauled from the field, and worked continuously. The quality of the product of decortication at the first trials was little better than simply delignated ribbon, some of it badly bruised and injured. At the second trial the decortication

was excellent, though one machine seriously injured its product in the delivery. This shows decided progress, and one of the immediate results of the trials just held will be a further improvement of both machines exhibited, the work having already been undertaken.

Another evidence of progress is the departure from the old idea of heavy constructions and complicated mechanisms. It has been shown that a farmer with 50 or 100 acres in ramie can not possibly extract the fiber from a crop of 1,000 tons of green stalks with a single machine. A gang of several machines of reasonably light, simple, and inexpensive construction, and propelled by low horse power, will be required in order that one power plant may run several machines. The newer French machines are built in conformity with this idea. The English machine tested at New Orleans is simplicity itself, and the latest American machine is so reduced in weight that it is almost portable. Reviewing the experience of even the last five years we are able to record such substantial progress in machine construction that the outlook is hopeful, and experimenters are beginning to feel great encouragement. Through repeated tests under official direction, there is little doubt that the ramie machine problem will be finally solved. In our own country there have been many attempts to produce an economically successful machine, and in the past few years probably a dozen machines have been brought to the attention of the public as possessing merit.

AMERICAN MACHINES.

Records of private trials of American machines, and of foreign machines brought to this country, have been forwarded to the Office of Fiber Investigations of the Department from time to time, but the results in a majority of cases have not given the information desired by the Department as to the capacity of the machines or their utility in continuous operation. A point which can not be overlooked is the fact that the records of private trials that are published by interested parties are liable to be considered in the light of advertisements, while the records of an official trial are at once authoritative, as the trial is made under specific rules and by a board of wholly disinterested persons. The advantage of Government trials in Europe and elsewhere has been recognized by all whom they interest, and it is only through these trials, as new machines are developed, that it has been possible to note the progress in the construction of decorticating devices.

The importance of authoritative knowledge regarding American inventions resulted in the first official trial of ramie machines held in the United States, which took place at Audubon Park, New Orleans, in September, 1892. Three of the leading machines of American invention at that time were entered for competition. These were given rigid tests under prescribed rules by a special board of experts, resulting chiefly in bringing out defects of construction rather than the establishing of records of capacity for American machines. Scarcely more

was accomplished at the early trials of ramie machines by the French Government, though in these trials beginnings were recorded by means of which subsequent progress has been marked. One result of the early French trials has been to stimulate invention, and the same may be said of our own efforts, as the New Orleans trials of 1894 proved. In the trials of 1892, as I have stated, it was necessary to strip the stalks of their leaves, and even after such stripping no machine was able to finish the first 500 pounds of stalks weighed out for its trial. In the tests of 1894 the stalks were run through the machines just as they were cut in the field, and both machines, as well as the smaller Allison machine tested a month later, met every demand in trials for continuous running that was laid upon it. As to quality of output, however, so good a report can not be made, though progress was recorded. The company controlling the English machine has already made important modifications in the construction of their machine, based upon suggestions made by the Department's expert. The new Allison machine likewise embodies decided improvements over the cumbersome device presented at the earlier trials. As the official report of these trials appears in Appendix B, at the end of this bulletin, it is not necessary to go into details regarding the manner in which the machines did their work. But it is not to machinery alone that we look to overcome the difficulties in the decortication of ramie, for it is possible to combine some form of process with a mechanical device and thus reach the final result.

AFTER-PROCESSES AND MANUFACTURE.

Those who are familiar with the varied processes in the extraction and first preparation of the fiber of flax and hemp will know that there are four stages, or operations, between the work of the farmer and that of the manufacturer, as the retting—in water or upon the ground—breaking, scutching, and finally the hackling, which combs out the tow and leaves the fiber in shape for the manufacturer. With ramie the retting is omitted, and the stalks are broken and cleaned either green or dry with all the gums in their natural condition. This corresponds to the breaking and scutching in the treatment of flax, the two operations being combined in one when the work is done on a machine.

DEGUMMING.

Before the ramie fiber is hackled (combed), it must be subjected to a chemical operation analogous to retting, to which the French have given the name "degommage"—hence the English term "degumming." The gums holding together the filaments of flax are soluble in water and therefore the retting accomplishes the separation of these filaments without difficulty. The gums which hold together the structure of ramie bast are not soluble in water, but require peculiar chemical treatment, which can be more economically applied to the extracted

RAMIE IN DETAIL: 1, RAMIE STALKS; 2, MACHINE-CLEANED FIBER; 3, CHINESE HAND-CLEANED FIBER

fiber than to the fibrous substance as it exists in its natural state in the stalks as harvested, and so the retting, or degumming, of ramie is usually done by the spinner, who, knowing the use to which the prepared fiber will be applied, degums the raw product to suit his own special needs. The farmer then has nothing to do with this operation, and need not interest himself in it further than to know if his product, when extracted and degummed, is fit for spinning, or up to a standard of quality that will insure profit from the culture; nor is this operation connected with the work of decortication.

Through the researches of the late M. Frémy, member of the French Institute, it has been shown that the gums and cements holding together the filaments of ramie are essentially composed of pectose, cutose, and vasculose, while the fiber itself is composed of fibrose, cellulose and its derivatives. The theory of degumming, therefore, is to dissolve and wash out the gums without attacking the cellulose.

In order to eliminate the vasculose and cutose, it is necessary to employ alkaline oleates or caustic alkalies employed under pressure, and even bisulphates and hydrochlorites. The gums being dissolved, the epidermis is detached and can be mechanically separated from the layers of fiber by washing. The larger number of degumming processes in present use embody these general principles.

Lest it may be understood that it is only necessary to place any raw ramie fiber in the degumming bath to separate at once its different constituents at a fixed cost, it should be recognized that upon the degree of cleanness of the fiber to be degummed depends the expense of the operation. It has been held by some inventors or others controlling machines for decortication, that it makes little difference whether the ribbon to be operated upon is simply stripped bark or a well decorticated product, as the resolving agency, followed by a volume of water, may be depended upon to render the separation complete, and to wash out all extraneous matters and give the pure fiber. The quantity that may be turned out in a given time, rather than quantity with quality, has been the main consideration. The waste matters in the bark of the ramie stalk must be wholly eliminated before the fiber is fit for the spinner, and if the machine does not accomplish any part of this work the degumming bath must do it all, but at a cost in direct ratio to the percentage of waste matters that remain in the ribbons after leaving the machine.

DIFFERENCE IN COST OF DEGUMMING MACHINE AND HAND CLEANED FIBER.

The difference in appearance between machine-cleaned fiber and the imported China grass is readily shown in the accompanying illustration (Pl. IV). Figure 1 represents a bundle of dried stalks, grown in Louisiana; figure 2, a mass of fiber extracted by a machine from green stalks grown in Louisiana, and figure 3 the China grass of commerce.

French experimenters have shown that it costs no more to degum the China grass that will fill a kier or tank of certain dimensions than the charge of simple stripped ribbons that will fill the same tank. Yet the weight of China grass that will fill this kier will be almost double that of the stripped bark, and while the kier of China grass will show a shrinkage (waste) of only 30 per cent, let us say, the loss from the stripped bark may be 66 per cent. To state this differently, a half-ton charge (1,120 pounds, French) of China grass may give 775 pounds of degummed fiber, the expense of degumming (at $20 per charge, let us say) being about 2⅗ cents per pound. Now the same kier, when charged with simple stripped bark, will hold only 660 pounds and give but 264 pounds of degummed filasse. But as the cost of degumming the contents of the tank will be the same in both instances, the last operation has cost 7½ cents per pound of pure fiber turned out. These figures are from French experiments made several years ago and recorded by Mr. de Landtsheer's brochure, "The Truth Regarding Ramie," though the cost of degumming has since been somewhat cheapened. The point is made clear, however, that whatever the cost for one filling of the tank, the expense of eliminating the waste matters from a charge of stripped bark must always be three times as great as the cost of reducing the same bulk of China grass. In these experiments it was shown that a ton of degummed fiber from China grass costs for the degumming $58, while a ton of degummed fiber from simple stripped ribbon costs $170. Raw fiber of different degrees of cleanness between these two grades give results in the same ratio.

From calculations based on more recent French experience, according to Mr. Toobe, the cost to degum 1 ton of decorticated fiber is set down at $30. From the statement that a crop per hectare of 3,900 kilos (8,580 pounds) of decorticated fiber will produce 2,340 kilos (5,148 pounds) of degummed fiber, it is possible to calculate the cost of the operation of degumming, per ton of degummed fiber, to be about $50. The only American figures at hand (estimated expense for a large factory, from actual working) show that the cost of degumming China grass per ton of degummed fiber will range from $60 to $75, with a shrinkage in weight of only 25 per cent. American figures, have been given that, are even lower than those of Mr. Toobe, but the fiber, judging from the samples submitted, would not bring as high a price in the market as either the French or the other American samples. Charles Roux states that 100 pounds of China grass degummed in France will yield 66 pounds of the finished product, while the same weight of machine-cleaned ribbon will only yield 35 pounds of the degummed filasse, or a little more than one-third. Referring again to Mr. Landtsheer's figures, we find that 100 pounds of simple machine-delignated bark will give 40 pounds of degummed fiber. This he calls quality A. A better grade of machine-cleaned ribbon, quality B, will give 50 pounds of degummed filasse, and quality C, approaching in appearance the Chinese fiber, 60 pounds of

degummed filasse per 100 pounds of the raw material, while the imported Chinese, hand prepared, will yield 70 per cent of degummed fiber. Additional evidence is furnished in recent statements to this office by Mr. Favier to the effect that while it costs about $50 per ton to degum China grass, the machine-extracted fiber, by the Favier system, costs $75 per ton, the raw fiber treated being very clean, with the waste matters of the bark partially eliminated. As to the commercial value of the degummed fiber, recent French figures quote it at about $300 per ton, or nearly 13½ cents per pound.

FOREIGN MANUFACTURING ESTABLISHMENTS.

Regarding the degumming processes in use in this and other countries, they are either patented or secret processes, and the Department has made no special investigations into their comparative merits and has no official knowledge of the formulas employed. Many specimens of the finished fiber produced by these processes have been received, however, carefully examined, and preserved in the reference collection of the Office of Fiber Investigations, together with the statements regarding special forms of machinery employed in the preparation of the commercial product. While there are no degumming factories in actual operation in the United States, as far as known, a number of fiber companies have satisfactory processes for degumming ramie, which will be employed when the active work begins.

From an examination of the best of these samples which have been produced on apparatus designed to turn out the product in commercial quantity, if not already prepared by the ton, it is safe to say that the question of economical degumming is settled. Indeed there are several large establishments in Europe which handle hundreds of tons of the Chinese raw fiber every year, either spinning the degummed product in their own factories or disposing of it to other concerns.

Reference has been made to the work of Mr. Favier, who employs his own process. The German concern at Emmendingen, Baden, has had no trouble with this branch of the industry, though the writer has not been able to secure from them detailed statements. The English company known as the "Boyle Fiber Syndicate" has developed an entirely satisfactory degumming process, which is employed at their spinning factory, recently established at Long Eaton, Derbyshire, the treated ramie costing 9½ to 10 cents per pound, according to the cost of the raw material, and they claim a loss of only 12 to 25 per cent in the treatment. There are no degumming establishments in active operation in the United States at the present time.

The beautiful examples of degummed ramie shown in the Museum of the Department, duplicates of those exhibited in the Fiber Investigations collections at the World's Columbian Exposition, were prepared by the Forbes Fiber Company, of Jersey City. An illustration (fig. 5) is here given of the digester used in treating ramie fiber by this process,

a special feature of which is a series of wire baskets to keep the fiber straight. The Jones & Warr Company, of Paterson, the Perseverance Company, of New Orleans, and The Boyle Fiber Syndicate, of London, which proposes to operate in this country, all have their own processes for treating the fiber and preparing it for the manufacturer, and will employ them in the near future.

At the present time the imported China grass is the raw product used in these establishments. In the first report of this office reference is made to the exceedingly limited supply of the raw material, and in the second report the world's commercial supply is placed at 10,000

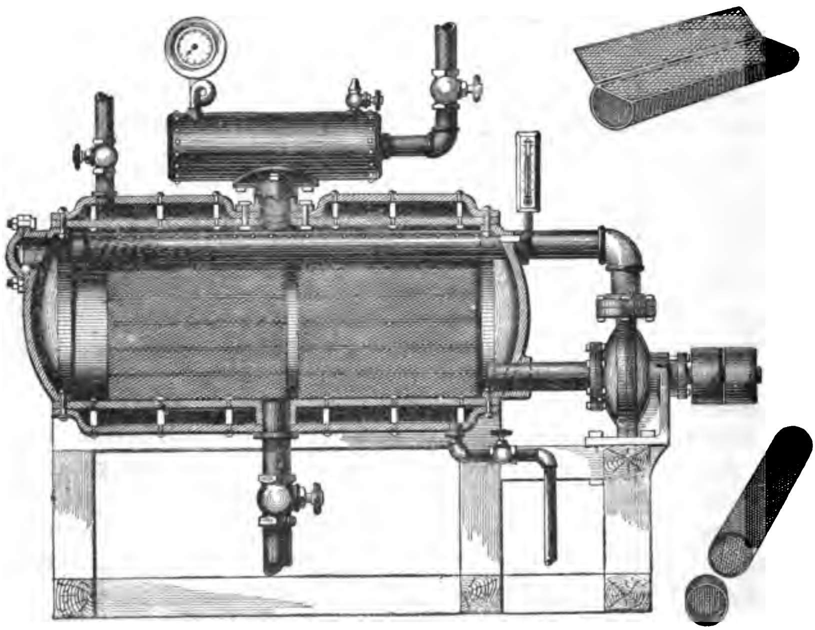

FIG. 5.—The Forbes digester.

tons, nine-tenths of which was said to be consumed in eastern countries. Since the publication of these reports the situation has changed somewhat, and it is now possible to secure 1,000 to 2,000 tons a month if desired. The consul at Hankow recently submitted to this Department a fine sample of fiber that could be laid down at New York at $130 in gold per ton, and stated that the present shipments from Hankow amount to about 10,000 tons annually. The supply can be increased to meet the demand.

The frontispiece was photographed from specimens in the Museum, and represents the dried ramie stalks from Louisiana, imported China grass (the same as degummed by the half ton), and a few examples of yarns, laces, and fabrics.

USE OF THE FIBER IN MANUFACTURE.

What is being accomplished in ramie manufacture? Leaving China and other eastern countries out of the account, as ramie fabrics have been manufactured in the East from time immemorial, England and France have taken the lead in the production of manufactured products of China grass, although fortunes have been dissipated in these enterprises, particularly when the industry was new. Exquisite samples of ramie manufacture were in possession of the Department of Agriculture as long ago as 1867, received from Messrs. Joseph Wade & Sons, of Bradford, England. During the last twenty-five years, up to the present, there have been factories in operation at various times in different parts of Europe which have produced ramie goods in almost endless variety.

It is not important to review in full the efforts that have been made in time past to introduce this fiber into manufacture. In recent years a number of more or less successful factories have been started for the production of ramie goods from the China grass of commerce, notably the German factory at Emmendingen, the Austrian mill at Bregenz, the French association of Féray et Cie. at Essonnes, of A. Goulon at Rouen, and others, the companies operated so successfully by Mr. Favier at Valobre, and, latterly, in England, where the recent success of French experimenters in economically degumming the fiber has led to the establishment of new companies for the production of ramie goods.

At the present time there are two filatures, or spinning mills, in France, two in Germany, one in Austria, one in Switzerland, and two English companies, one of which, the Boyle Fiber Syndicate, operates at Long Eaton.

Probably the two most successful spinning mills are those operated at Valobre, France, and at Emmendingen, Baden, Germany. The former, by the Favier Company, is the successor to La Ramie Française, which figured so prominently in France in everything pertaining to the ramie industry for ten years or more since 1881. The Valobre factory is now spinning annually 150 tons of yarns, 50 tons of sliver, and 70 tons of noils. It spins yarn in numbers up to 90 in fineness. The company has added a dyehouse to its plant, and is steadily enlarging its mills.

At the Emmendingen mills about 180 tons of China grass were treated last year, the product of the mills returning about $183,000. During the past two years particularly there has been a rapidly increasing demand for the ramie yarns and fabrics turned out in Germany, and such products are now considered regular articles of commerce.

Thus we see that ramie spinning mills really exist in Europe, and that their products are easily disposed of, and not at a loss, as heretofore. What are the goods manufactured? Regarding the work at

Valobre, the Department is informed that it produces special threads for lace, passementerie, linen fabrics, and other products of a higher grade, in which the price of the materials is of less importance while waiting until the abundance and cheapness of the raw material will permit the introduction of threads for coarser goods for which there will be a large demand. For linen goods ramie is particularly applicable on account of its great resistance, both with regard to washing and to wear. The most important hotels and railway companies in France are said to have entirely adopted the use of ramie. The city of Paris has also adopted this linen for the service of its twenty arrondissements. It is ordered for the dressing of wounds in several hospitals, including those of the army and navy. The minister of war employs it for the cordage of balloons, powder sacks, etc., and the Bank of France now uses nothing else for the manufacture of its notes but the ramie supplied by the Valobre factory; it has found the new bank note of ramie to be finer, more durable, and capable of receiving a better impression—consequently rendering forgery of the notes much more difficult, if not impossible.

As to the possibilities of ramie manufacture there seems to be no limit. Stuff goods for men's wear, upholstery, curtains, laces and embroideries, plushes and velvets, stockings, underclothing, table damask, napkins, handkerchiefs, shirtings, sheetings, sail duck, carpets, cordage, fishing nets, and yarns and threads for various uses not enumerated.

Regarding these various uses of ramie fiber in manufacture, however, M. Roux says we should not conclude that this textile is destined to be employed so largely. The cost of its preparation will always prevent its common use as a substitute for the textiles that can be more cheaply grown and prepared. He concludes that while it has brilliancy it has not the elasticity of wool and silk, nor the flexibility of cotton; but it will always be preferred for making articles requiring the strength to resist the wear and tear of washing or exposure to weather. This facility to imitate all other textiles is one of the principal causes which has kept back the development of the ramie industry; and if, instead of launching out into a series of experiments, attention had been concentrated upon the exclusive manufacture of those articles to which the properties of the plant were peculiarly and naturally adapted, this industry would probably be in a more advanced condition than it is at present. The Department of Agriculture has held to this position since its work in this field was begun. The folly of building up a ramie manufacturing industry on a false basis, that is, employing the textile as a substitute for something else, is to be deprecated. The fiber should be used in those articles of economic necessity which would appear on the market as ramie, that any distinctive merit the textile may possess will become known, not only to the ramie trade, but to the consumers of the product. Even then there will be an

abundant demand for the textile, and for the waste fiber or combings, for use in mixing with other textiles, or for employment as out and out substitutes for them. Nor will the wearing qualities of these manufactures at all suffer through the substitution. Not so at the present time, where the employment of jute fiber in manufactures for domestic use is often a positive fraud.

MANUFACTURE WITHOUT CHEMICAL TREATMENT.

Before leaving the subject of ramie manufacture, reference should be made to a possible use for the fiber without chemical treatment. In a communication from Mr. de Landtsheer, of France, it is suggested that the dry-system fiber can be employed in cheaper manufactures without degumming, as it will be possible to card it from the machine direct without subsequent treatment, and that a special industry might be created by employing this fiber, which would supply a market that farmers could satisfy. Mr. Forbes has made a similar suggestion, indicating the possibility of creating such an industry in the United States which would in no wise interfere with the degumming industry. This fiber, which is somewhat lighter colored than jute, could be wrought into fine twines of great strength—fish lines, nets, and even into fabrics for coarse uses where great strength would be a greater consideration than appearance and finish. The Southern States and California would be greatly benefited by such an industry, which is not beset with the difficulties attending the use of American-grown fiber in the higher grades of manufacture that necessitates large outlay for degumming and combing, with considerable waste.

Ramie manufacture in our own country can hardly be said to have reached the commercial stage, though quite satisfactory results have been attained. The simpler forms of ramie fabrics were experimentally manufactured twenty years ago, but serious effort belongs to the present decade.

Regarding the present status of this branch of the industry in the United States, it is only necessary to refer to the beautiful collections of degummed and manufactured ramie shown by the Department at the World's Fair at Chicago as evidence of what the United States will be able to accomplish in this direction when the industry is fairly launched. The beautiful examples of perfectly parallel, straight, degummed fiber there exhibited, prepared by the Forbes process and by Messrs. Jones & Warr, make it certain that we shall not be dependent upon Europe for our spinning material, and the fabrics that were exhibited by the last named are as good in their class as anything the European manufacturers have sent to us. But there is no need to dwell on this phase of the industry, as successful growth and the machine questions are the vital considerations. These are the subjects which the governments of many countries have been and are now interested in, to the end that the agricultural classes may be

properly informed on the one hand and guarded from imposition on the other. The spinning and weaving of ramie are no longer experiments, and with these industries fairly established, as they are in Europe, improvements in machinery and processes to enhance the beauty of the products, to supply new forms of fabrics, and to reduce the cost of manufacture, will naturally follow, and the ramie industry will take its place with the linen industry and the other vast textile occupations which are such sources of wealth to the countries where they are carried on.

A WORD TO FARMERS.

While great progress has been made in the past few years, it can hardly be said that the time has come for ramie to take its place at once with the great staples as a money crop. But the time has come for farmers to experiment seriously with culture, in order to become familiar with the growth of the plant and to secure roots for future planting on a larger scale, for at present ramie roots are exceedingly scarce and hard to obtain. Let the grower make a beginning with one or more acres, studying the crop to learn the peculiarities of the plant and the special practice necessary for successful cultivation. Such a small beginning will give him a positive advantage, when the industry is fairly established, over the farmer who has no experience or knowledge of proper cultivation.

In conclusion, there is urgent need of further carefully conducted experiments with ramie in this country under expert direction, in order to show the best results attainable and to ascertain conclusively the cost of the varied operations and the value of the crop to the farmer. But large appropriations in the hands of mere promoters, without experience and without practical knowledge of the requirements of the industry, or full appreciation of the obstacles that have hindered advancement, would be money worse than thrown away, for failure would result only in an injury to the industry. And the same may be said of Government aid to establish experimental spinning factories. There is no problem connected with the manufacturing of ramie that is difficult of solution, and ramie fabrics must ere long be produced by American industrial enterprise just as they are now produced in Europe. Culture and the machine question only invite our serious attention.

And in this connection it may be said that if the Department of Agriculture has rendered no further service to the ramie interest of the South it has prevented farmers from making those costly mistakes which in every new enterprise undertaken by the uninformed have so often resulted in financial failure.

APPENDIX A.

THE RAMIE MACHINE TRIALS OF 1892.

As a matter of record in the bulletins of the Fiber Investigations Series, the following report of the trial of ramie machines in New Orleans, in 1892, is republished from the Statistician's Report for September and October of that year. Being the report of the special agent, it also embodies the special report of the board of experts appointed to conduct and witness these trials, which was prepared at the close of the trials.

REPORT ON THE TRIALS.

The interest attaching to the problem of economically decorticating the fiber of ramie, as is well known, has stimulated invention in both the New and Old worlds during a period of twenty-five years or more. The official trials in India, the trials of 1888 in Belgium, and of 1889 and 1891 in France, are matters of history. In our own country there have been many attempts to produce an economically successful machine, and in the past two or three years probably ten machines have been brought to the attention of the public as possessing merit.

The records of many private trials of American machines and of foreign machines brought to the country have been forwarded to the Office of Fiber Investigations of the Department during the past two years, but as the results did not give the information desired by the Department as to the capacity of the machines or regarding their utility in continuous operation, an official trial of American machines was deemed important.

Arrangements for the trials in New Orleans, which were set for the last week of September, were begun almost a year ago. A contract was entered into with Col. Gustave A. Breaux,* of Oakbourne plantation, La Fayette, La., to grow 10 or more acres of ramie stalks to afford a sufficient supply for tests of a day's running of ten hours, instead of the usual tests of a few minutes, which demonstrate little regarding the ability of a machine to run continuously.

The Louisiana Sugar Experiment Station, Audubon Park, New Orleans, under the direction of Prof. W. C. Stubbs, was chosen as the place of trial, there being ample space and power for the purpose, which could not be well secured nearer to the supply of growing ramie. On July 1, 1892, the following circular was sent out to machine inventors, and others, interested in a trial of decorticating machines:

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE ASSISTANT SECRETARY,
Washington, D. C., July 1, 1892.

DEAR SIR: Arrangements are well under way for the trials of machines and processes for the decortication of ramie, to be held at Audubon Park New Orleans, the last week in September, 1892.

At these trials each machine or process entered will be required to work at least ten hours, or at the discretion of the board of experts. The working will be either upon green stripped stalks, green stalks with leaves, or upon dried stalks, or upon

* Colonel Breaux had 30 acres planted in ramie at Oakbourne.

all three forms, according to the type of the machine. The running will be conducted by Special Agent Charles Richards Dodge, in charge of fiber investigations, assisted by the board of experts appointed by the Secretary of Agriculture, each company entering the contest to supply the necessary attendants for its own machine, and bear all expense of transporting machinery to and from the place of trial, and the expense of operation, save as noted below.

The Department will supply the ramie stalks, the power, and floor space only, the machine owners to furnish necessary belting and a split pulley for their power connection. Size of shaft, $2\frac{1}{8}$ inches. A foreman will be appointed by the Department, who will have charge of the power, and who will assign space and attend to all mechanical details.

It will be advisable to place machines in position some days prior to the official trials in order to have everything in perfect running order, as there can be no delays. The Department will not furnish stalks for private trials made by owners of machines; these can be obtained, however, from Oakbourne plantation, where the Department's supply is being grown, at the Government rate per ton. Address Col. Gustave Breaux, No. 5 Carondelet street, New Orleans, La.

The Department will take possession of the product of decortication until after the official weighings, reserving the right to hold such portion of it as it may desire for further use and experiment.

Each machine will stand on its own merits in the trial, and be given credit for actual performance without relation to other machines, and without attempt at classification other than as refers to the class of material upon which it operates, and the final report will be made on this basis. No credit of time for stoppage for readjustment, fouling of the working parts, or breakage will be allowed, the running to be timed by the watch.

Special points to be considered in judging merit are:

Continuous running, quantity of cleaned fiber turned out, and quality of ribbons, or degummed fiber. First-quality ribbons are those perfectly delignated and decorticated, untangled, and without bruises, or in a state more nearly resembling the China grass of commerce. It should be noted in this connection that poorly cleaned ribbons, with portions of the wood adhering, and with more or less of the brown epidermis intact, can not be economically treated in the final processes of degumming and rendering the fiber fit for spinning. Bruised ribbons, likewise, entail similar loss through large percentage of waste in final manipulation.

In entering your machine please reply to the following questions, an early response being solicited:

(1) What is the name of your company?
(2) By what name is your machine designated?
(3) What horse power does it require?
(4) What class of material is it specially constructed to work upon?
  (*a*) Green stalks with leaves.
  (*b*) Green stalks stripped of leaves.
  (*c*) Dried stalks.
(5) How many attendants does the machine require, including those who handle the stalks and remove the fiber?
(6) What actual floor space does the machine (or apparatus for process) require?
(7) Give in brief a description of the construction of the machine or apparatus, stating what it is claimed to accomplish.
(8) Do you agree to all the conditions as set forth in the above circular?

Shipments may be made to the Sugar Experiment Station, Prof. W. C. Stubbs, director, Audubon Park, New Orleans, La. Please use the inclosed official envelope in your reply. Any further information will be given by letter upon application.

I remain,

Respectfully, EDWIN WILLITS, *Assistant Secretary.*

Four entries only were received in response to this circular, and but three machines were placed in position at Audubon Park, the fourth machine not having been completed in time for the trials. The special report of the board of experts appointed by the Secretary of Agriculture to conduct and witness the trials, is herewith presented:

REPORT OF THE BOARD OF EXPERTS.

The official trials of ramie machines, under the auspices of the Office of Fiber Investigations of the United States Department of Agriculture, set for the last week in September at Audubon Park, New Orleans, came off on the 30th of September, and included trials upon jute stalks as well as upon stalks of ramie.

Three machines were entered for trial, as follows: The Kauffman machine, by the Kauffman Fiber Company, of New Orleans, La.; the Felix Fremerey decorticator, by

the Felix Fremerey Decorticator Company, of Galveston, Tex.; the fiber delignating machine (known as the J. J. Green machine) of the United States Fiber Company, of Versailles, Ky.

The Kauffman machine.—According to the entry of this machine it requires 15 horsepower; it works upon green stalks stripped of leaves and upon dried stalks. Four attendants are required to run it; floor space occupied, 6 by 14 feet. The machine is termed a decorticator for ramie, jute, and hemp. In operation it is stated that the stalks, after being brought to the feeding table and presented to the machine, first pass through three brass crushing rolls about 8 inches in diameter, then, being deflected, pass downward through a powerful brake arranged with two slats working into three by means of two pairs of eccentrics; thence to reversible slat beaters (of wood), their action being controlled by a lever operated by the foot of the feeder. From this point the material passes down through two rolls covered by carriers or aprons of canvas, moving horizontally, the fiber to be removed by the hands of an attendant at the opposite end of the machine.

The Fremerey machine.—In the entry of this machine about 5 horsepower is stated. The machine is arranged to work upon green stalks, either stripped or with the leaves, and upon dry stalks. It occupies a floor space of about 5 by 18 feet. The machine requires five attendants, three of whom may be boys. There is a feeder, with iron grippers, that seizes the stalks automatically at the platform, bringing them before a pair of rollers, the lower one grooved and the upper one provided with rubber rings in order to carry the stalks to the knives. The second pair of rollers consists of an upper roller provided with circular knives, and the lower roller provided with grooves. Then comes the third pair of rollers, the upper one of which has slightly flattened corrugations around the circumference of the roller for deflecting the two halves of the stalk after being slit, the lower one being smooth. The fourth pair of rollers are both smooth and are for the purpose of crushing in the dry state and pulverizing the resinous matter. Then follow three pairs of fluted rollers for the purpose of breaking the woody matter into fragments one-half to three-quarters of an inch in length. These are followed by a pair of beater cylinders, called a double-acting beater, with steel plates or winglets, for the purpose of brushing the broken wood from the ribbons. At the end of the machine is an iron carrier which carries the cleaned ribbons out of the machine, where it is taken by the operators.

The J. J. Green machine.—Ten horsepower is named as the power required to drive this machine. The entry states that it works upon dried stalks (but it is also expected to work green stalks with or without leaves). Five attendants are required for full capacity, three of whom may be boys; it occupies a floor space of 8 by 12 feet. In the operation of the machine the stalks are put into the machine at the top, where they are grasped by a pair of hard rolls that crushes all to one size and presses them into a pair of small diameter gum rolls placed very near together.

Opposite the axis center of these runs a band knife, which splits the stalks from end to end as they are pressed upon it by the gum rolls. The stalks being now divided into halves, the machine thereafter operates on each separately, one-half of the stalk passing out on each side of the machine. Immediately beneath each gum roll is a stationary bar, called the stripping bar, around whose square corner the half stalk is turned, the fiber side being next the bar. Beneath this bar is a stationary shaft carrying a loose sprocket wheel on each end, and a stationary bar resting about $1\frac{1}{4}$ inches below the bar next the roll. Over the sprocket wheels run link belts that have their other bearing about 2 feet farther out from this shaft. These chain belts are connected by steel rods placed some 6 inches apart.

Immediately behind the gum roll is another of these similarly constructed chain aprons which runs as a companion apron with the first described. When running, the rods of one of these aprons come just in front of those of the other, and both are held in the same plane by bars above and below them which extend from one of their shafts to the other. These aprons run faster than the feed, so that when about 6 inches of stalk has fed below the stripping bar their respective rods grasp it between them and produce a friction pull sufficient to thereafter strip the ribbon from the wood at the corner of the stripping bar. Thereafter, when about every 3 inches of stripped wood projects below the stripping bar, one of the rods of the lower apron, passing between the stripping bar and the previously described bar below, snaps off this 3 inches and restores to the ribbon any adhering ends of fiber strands. The wood drops into a hopper beneath, where a carrier removes it to outer end of machine.

The ribbons are thus delivered on each side of machine to outer chain aprons, which bring the two halves together again, and finally deliver them straight and with even ends to the receiving attendant.

RULES GOVERNING THE TRIALS.

The special rules and instructions governing the conduct of trials were promulgated by the Assistant Secretary of Agriculture, Hon. Edwin Willits, and are as follows:

No machine will be tested which has not been formally entered by the 24th day of September, with answers to questions in circular of conditions of July 1.

The tests will be made upon green stripped stalks, green stalks with leaves, and upon dried stalks.

The tests upon green stripped stalks shall be for ten hours' continuous running with no allowance of time for stoppage for readjustment, or for cleaning when working parts have become gummed or otherwise fouled, or for breakage. During the noon intermission, should it be necessary, no readjustment, cleaning of parts, or repair, other than oiling, will be allowed, otherwise the test for "continuous running" must be considered for five hours instead of ten. Product will be weighed at end of each five hours' run.

The tests upon dried stalks shall be for five hours' continuous running, the rules relating to time allowance to apply as for the trials on green stripped stalks.

The tests upon green stalks with leaves shall be with ton lots of stalks to the amount of one or more tons, at the discretion of the board of experts, the running to be continuous, the rules relating to time allowance to apply as for the trials on green stripped stalks.

All stalks used in tests shall be first weighed and the weight recorded, and all wet ribbons shall be weighed at the close of each test in the condition in which they are received from the machine. This rule does not apply to chemical or other process decortication where the cleaning and degumming is a continuous operation, the final product to be weighed in both wet and dry states.

All ribbons or other material produced will be considered the property of the Government and must not be removed or in any way interfered with until the close of the trials, the Department reserving the right through its representatives to retain all the material for subsequent test and possible manufacture.

Each machine will stand on its own merits in the trial and be given credit for actual performance without relation to any other machines without attempt at classification other than as refers to the class of material upon which it operates, and the final report will be made on this basis.

The board of experts appointed by this Department to conduct and witness the trials is as follows: Charles Richards Dodge, special agent, chairman; Talma Drew, secretary; Dr. Thomas Taylor; Prof. W. C. Stubbs; Prof. S. M. Tracy.

The superintendent of power and space is Prof. R. T. Burwell, who will attend to all details of this portion of the work.

The board is empowered to deal with any questions which may arise during the trials, and its decision by a majority vote of its members will be final:

The 10 acres of ramie especially cultivated at La Fayette for the trials were reported to be in good condition, and instructions for rapid cutting and prompt shipment were early given in detail by the Department. The ramie stalk produced at Oakbourne plantation appeared upon careful examination, after having been received at Audubon Park, to have been properly grown and suitable for the tests, but owing to delays in the transportation (which were not expected by us, and which we had hoped were amply provided against) of the 150 miles from La Fayette to Audubon Park the material was heated and spoiled in the transit. One car was loaded September 19 the other September 24, and both were received September 28. This delay prevented carrying out the instructions of the Assistant Secretary as relating to time tests, the ten-hour trials having been arranged to begin at 7 o'clock on the morning of the 27th of September. The Oakbourne supply, green stripped stalks and dry stalks, having been rendered worthless for testing the machines, as above stated, a quantity of about two tons of green stripped stalks and stalks with leaves was secured from the plantation of Captain Willet, 2 miles beyond Algiers, across the river, and brought by teams to Audubon Park. These stalks, and the stalks from a plat of jute growing on the farm of the experiment station, supplied the material used in trials which subsequently took place September 30.

TRIALS ON GREEN STRIPPED RAMIE.

The first trial was with the Kauffman machine, 500 pounds of green stripped stalks having been weighed out for the test. Of this amount 332 pounds of stalks were run through the machine in forty-two minutes, when the machine clogged. The result in wet ribbons was 88 pounds, and 168 pounds of stalks remained unworked, owing to the inability of the machine to proceed further. (See tabular statement.)

The second trial was with the J. J. Green machine, 500 pounds of green stripped ramie stalks having been weighed out for the test. Of this quantity 225 pounds of stalks had been delignated in one hour and thirty-five minutes, producing 57½ pounds of wet ribbons, 275 pounds of green stalks remaining unworked, owing to the inability of the machine to proceed further. (See tabular statement.)

Mr. Fremerey declined to enter this trial after 500 pounds of green stripped ramie stalks had been weighed out, claiming that the stalks were too uneven in size, the construction of his machine requiring medium stalks. It should be noted that a very small percentage of the stalks secured by the board from the Willet plantation were of young slender growth and of short length.

TRIALS ON JUTE STALKS WITH LEAVES.

The first trial was with the Fremerey machine, 100 pounds of freshly cut jute stalks with leaves having been weighed out for the test. These were run through in thirty-one minutes, giving 37¾ pounds of wet ribbons. (See tabular statement.)

The second trial was with the Kauffman machine, 100 pounds of freshly cut jute stalks with leaves having been weighed out for the test. This quantity was run through in twenty minutes, the result being 32 pounds of wet ribbons.

TABULAR STATEMENT.

The following tabular statement of the results of the trials, with explanatory notes, is presented:

Green stripped ramie.

Test.	Machine.	Stalks.	Time of test.	Wet ribbons.	No. of men.
		Pounds.	*Hrs. Min.*	*Pounds.*	
First	Kauffman	332	*a* 42	*b* 88	3
Second	J. J. Green	225	*c* 1 35	*d* 57½	5

Jute with leaves.

Test.	Machine.	Stalks.	Time of test.	Wet ribbons.	No. of men.
Third	Fremerey	100	*e* 31	*f* 37¾	4
Fourth	Kauffman	100	20	*g* 32	3

a This covers the time from starting the machine and the moment when it became clogged and stopped. The upper waste apron gave trouble almost at the beginning of the test and stopped in fourteen minutes, after which the waste carried by this apron was removed by hand. The ribbon delivery apron clogged and stopped in forty-two minutes. After forty-six minutes, spent in overhauling the machine, the operator made an effort to proceed when it was found that one of the eccentrics was heated and cut: the upper aprons still refused to work, and the test was abandoned.

b Wet ribbons badly tangled and broken, and showing a large percentage of woody waste. The hurds contained a small percentage of waste fiber.

c In this time there were three stops, aggregating sixty-seven minutes, to clean and readjust the working parts of the machine, the knife failing to split the stalks; the test after the last stop was abandoned.

d The machine gave a smoothly delignated ribbon, with small percentage of woody waste, save in a few stalks, in each instance, just before the machine became clogged.

e There were two stops, aggregating eighteen minutes, to readjust the machine.

f Smooth ribbons, practically free from woody waste.

g Ribbons well deliguated, with very small percentage of woody waste. The fiber occasionally is somewhat broken.

The tests upon dry ramie stalks were abandoned, as the material dried for the purpose at Oakbourne was found in too damp a condition to work as dry ramie, owing to contact in the car with a quantity of green stalks during the ten days the car was in transit.

After the results of the trials with green stripped stalks had been shown, the trials upon green stalks with leaves were necessarily abandoned, and a quantity of material, both stripped and unstripped, was turned over to the director of the experiment station for such future use as might be desired by the station authorities.

In presenting the above statements and figures the board of experts makes no attempt to estimate the run of any machine for a day of ten hours, based upon the results of the trials as above, believing that such figures can only be misleading, and that the official reports of all such trials should present the actual facts brought out by the operation of each machine under trial.

CHAS. RICHARDS DODGE, *Chairman.*
TALMA DREW, *Secretary.*
THOMAS TAYLOR.
W. C. STUBBS.
S. M. TRACY.

CONCLUSIONS.

The longest running at the Paris trials of 1889, which were attended by me, was thirty-three minutes, and the largest quantity of stalks cleaned by any one machine in one trial 132 pounds, while the shortest running was for a minute and a half, and the smallest weight of stalks 15½ pounds. In point of fact, the strength of a machine and its actual capacity can not be demonstrated by such short trials, and especially when the machine goes smoothly through with the small amount of work allotted to it. The special point was therefore made, in arranging for the first trials of American machines, that the test should be for ten hours. And it is to be regretted that this part of the programme could not at least have been entered upon by the board of experts in the trials at New Orleans, though, in view of the results of the two trials, with 500 pounds of ramie stalks, when the defects in the machines were shown which caused the abandonment of the tests before all the stalks had been run through, it is probable that the final results would not have been far different.

While the figures for a day's work, based on the results of short running, are wholly misleading, it is interesting to note that the output of the Kauffman machine, during the forty-two minutes of continuous work before it clogged, represents 4,743 pounds of green stalks in ten hours of continuous action, or a little over 2 tons, with an output of 1,257 pounds of wet ribbons, equal to about 420 pounds of dry ribbons, which weight would be considerably reduced after the loose hurds and woody matter remaining in the ribbons produced by this machine had been eliminated.

In like manner, were the J. J. Green machine to run continuously for ten hours, turning out ribbons at the rate of speed shown when in actual operation (that is, deducting the sixty-seven minutes spent in cleaning and readjustment), the output would have shown a capacity of 4,821 pounds of stalks and 1,232 pounds of wet ribbons, equal to about 410 pounds of dry ribbons. But, as shown, both machines were unable to finish the 500 pounds of stalks weighed out to each for the trial.

The results of the New Orleans trials are satisfactory as far as they have demonstrated the status of the machines entered, and established an American record that gives a starting point for future comparison, as the results of other trials are made known. It is to be regretted, however, that a larger number of machines were not represented. In this report comparisons can not be made with the best foreign machines though I shall endeavor to cover the whole ground in a special report, Bulletin No. 5, Fiber Investigations, to be issued at an early date.

One point, demonstrated beyond all doubt at the recent trials, is the perishable nature of green ramie, either stripped of its leaves or unstripped, and the experience recorded emphasizes the importance of taking the machine into the field where decortication in the green state is carried on. Two or three small bundles of ramie stalks *with leaves*, cut and tied up on the Willet plantation before noon of the 29th, had begun to show signs of heating on the morning of the 30th, though the stripped stalks and remainder of the unstripped stalks were in perfect condition.

It is an interesting point for future experiment to determine whether ramie stalks can be perfectly dried in best condition for machine working in Louisiana, owing to the greater humidity of this section compared with other sections of the country suitable to ramie culture.

It would seem from my observations in Louisiana that slight kiln-drying will be necessary, after at least ten days of sun-drying in the field, in order that the stalks may be made sufficiently brittle for the machines to separate the woody matter readily.

And the question of profitable cultivation is another problem which can be settled only by careful experiments on a large scale.

As has been previously stated in reports of this Department, the future of the ramie industry in America depends upon a careful consideration and understanding of the whole situation, studied connectedly—culture, stripping of the fiber, and the preparation of the fiber for manufacture.

APPENDIX B.

THE RAMIE MACHINE TRIALS OF 1894.

The second official trials of ramie machines in the United States was held in New Orleans in October, 1894, under the auspices of the Louisiana Agricultural Experiment Station, Prof. W. C. Stubbs, director, although the special agent in charge of fiber investigations was authorized by the Department to witness the machine tests and make a report.

The ramie stalks used in the trials were grown from roots planted by Professor Stubbs on the grounds of the experiment station early in the season, the yield of the second cutting being at the rate of 5 to 6 tons of green unstripped stalks per acre.

The special rules and instructions governing the conduct of the trials were promulgated by the committee of experts appointed by the director of the Louisiana Sugar Experiment Station, and are as follows:

RULES GOVERNING THE TRIALS.

The tests will be made upon green stalks with and without leaves, and upon dried stalks.

The tests shall be for continuous running, with no allowance of time for stoppage for readjustment, for cleaning the working parts when they have become gummed or otherwise fouled, or for breakages.

The test upon dried stalks shall be for 500 pounds or more, at the discretion of the committee, continuous running, the rules relating to time allowance to apply as for the trials on green stalks.

The tests for green stalks with leaves shall be for 500 pounds or more, at the discretion of the committee, the running to be continuous, the rules relating to the allowance of time to apply as on the trials for green stalks.

All stalks to be used in the test shall be first weighed and the weight recorded, and all ribbons shall be weighed at the close of each test in the condition in which they are received from the machine.

All ribbons and other material produced will be considered the property of the Louisiana Sugar Experiment Station, and must not be removed or in any way interfered with until the close of the trials; the station reserving the right to transfer any portion of this material to the United States Department of Agriculture for additional tests and possible manufacture.

Each machine will stand on its own merits in the trial, and be given credit for actual performance without relation to any other machine and without attempt at classification other than refers to the class of material upon which it operates, and the final report will be made on this basis.

The committee of experts appointed by the station to conduct and witness the trials is as follows:

Charles Richards Dodge, special agent in charge of fiber investigations, United States Department of Agriculture; Prof. S. M. Tracy, director Mississippi Experiment Station; Dr. W. C. Stubbs, director Louisiana Sugar Experiment Station.

The superintendent of power and space is Prof. R. T. Burwell, who will attend to all details of this portion of the work. The committee is empowered to deal with any question that may arise during the trials, and a decision of a majority vote of its members will be final. On October 3 the trials began.

REPORT OF THE COMMITTEE.

Two machines were entered for trial, one by the Textile Syndicate, No. 72 Finsbury Pavement, London, England, for green decortication, the other by Samuel B. Allison, of New Orleans, for dry decortication, Mr. Allison being the inventor and patentee.

It was intended that these trials should be held in September, but difficulties encountered in the custom-house in the entry of the English machine delayed them until the first week in October. The ramie used for the trial of the Textile Syndicate machine (fig. 6) was grown upon the grounds of the Louisiana Sugar Experiment Station, and was cut as used. The trials occurred upon the 3d, 4th, and 10th of October. On October 3 the Textile Syndicate machine was tested directly for

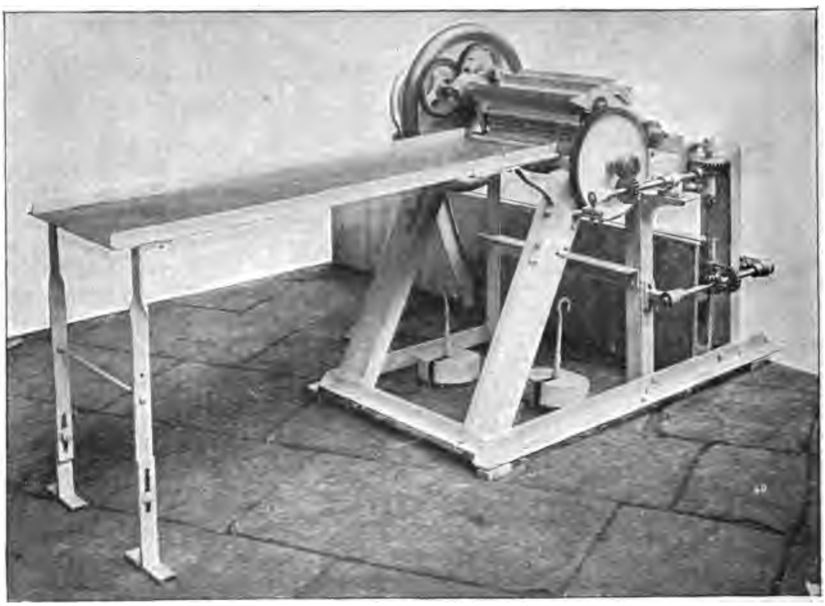

FIG. 6.—Textile Syndicate decorticator.

quantity, 1,000 pounds of green stalks with leaves, freshly cut, being run through the machine in one hour five and one-half minutes, yielding 196 pounds of wet ribbons, giving 56 pounds of dried fiber.

On October 4 another test was given this machine for both quantity and quality. Five hundred pounds of green ramie stalks with leaves were worked in twenty-four minutes, and yielded 116½ pounds of wet ribbons, giving 30½ pounds of dry fiber. The work of decortication appeared to be satisfactorily accomplished, but in the absence of a carrier to deliver the ribbon, the fiber was so badly tangled in the delivery as to seriously impair its commercial value. The carrier supplied with the machine on the first trial failed utterly to perform any work, and therefore in the second trial was not used, but instead the fiber was removed by hand as fast as dis-

charged from the machine. To test the capacity of the machine for thorough work, five runnings with varying numbers of stalks were made as follows:

Run 1. Six stalks; fiber straight and delivered in good order.
Run 2. Ten stalks; fiber straight and delivered in good order.
Run 3. Sixteen stalks; fiber straight and delivered in good order.
Run 4. Twenty-five stalks; slightly tangled.
Run 5. Thirty-six stalks; badly tangled.

In the performance of these experiments the fiber was removed carefully from the machine by hand and three tests of each were made. In the trials three men, not counting the engineer, were required to attend the machine while running.

TESTS WITH JUTE AND COTTON STALKS ON THE SAME MACHINE.

Eighty pounds of *Corchorus capsularis* were put through the machine in six and three-fourths minutes, giving 39 pounds of wet ribbon; secondly, 54 pounds of *Corchorus olitorius* were run through the machine in three and one-fourth minutes, giving 21½ pounds of wet ribbon. The ribbons of both varieties contained a considerable amount of wood in splinters. The *Corchorus capsularis* gave the best and cleanest ribbon.

A small quantity of the limbs of India cotton was run through this machine, but the results were not sufficiently interesting to continue the experiment.

THE ALLISON MACHINE TRIALS.

The Allison machine was not entered for trial until October 2. A preliminary run was attempted on October 3, when it was discovered that its foundation lacked solidity, causing too great vibration for safe running to full capacity of machine; therefore the official trials of this machine were postponed until the 10th and 11th of October, in order to give time to lay the proper foundation. By October 10 Mr. Allison having placed his machine in position with a good foundation, trials were begun on October 10 and continued through the 10th and 11th. To this machine both engines of the sugarhouse were attached, and then not enough power was given for its maximum capacity of work.

The first trial was on October 10 with 112 pounds of dried ramie stalks without leaves, some of which were badly broken. These stalks were cut from Captain Willet's field, August 1, and represented the growth from June 6, at which time the field was cut. It had been exposed to the August gale, taken up and dried, and put under shelter to ascertain the damage done by it. The men required to work the machine were as follows: Feeder, passer, apron man, engineer, and a man to hold down "idler" which worked the beaters. Another man would be needed to put the ramie on the feeding apron if continuous running were required. The trial began at 3.30 p. m.; the machine ran five and three-fourth minutes, and choked from over-feeding; took till 5 o'clock to clean the machine; slightly choked at 5.35; started again at 5.42, and finished at 5.51 p. m. Fiber, 30 pounds. Total time of trial, two hours and eleven minutes; actual running time, fifty-two and three-fourths minutes.

In this trial the beater was wrapped five times, and was stopped and cleaned by hand without stopping the engine; both the cutter engine and centrifugal engine of the sugarhouse were required to run the machine, and then with insufficient power. Fiber delivered in somewhat tangled condition, but well cleaned of wood. This is equivalent to 1,273 pounds of dry ramie stalks in ten hours, if the machine were run continuously. Per cent of fiber, 26.79, or 535.8 pounds per ton of 2,000 pounds of dry ramie.

Trial No. 2 was on stripped green ramie stalks, with saturation, October 11. In this trial, which began at 2.52½ p. m., saturation was practiced by using water from the tower of the sugarhouse and passing it through a perforated pipe running the length of the top rollers. The following are the results: Three hundred and eighty pounds of stripped stalks were obtained from 655 pounds of unstripped stalks.

engaging the attention of a feeder, passer, carrier, apron man, "idler" man, and machinist; finished at 3.42½; time, fifty minutes. Beater stopped three times to remove fiber without stopping engine. Some wood remained on the fiber, which was too wet to weigh at once. It was handled with great care, dried on ropes in the sun, and weighed October 15. Result, 25¼ pounds of dry fiber.

Trial No. 3 was on 234 pounds of unstripped green stalks. Began at 4.23 p.m.; stopped at 4.40 p.m.; time, seventeen minutes. No stop was made, but the knife was used to cut the fiber wrapped around the corrugated rollers. Started without saturation, but soon had to use it, a number of leaves adhering to fiber; considerable wood left in it. Work done equal to 8,259 pounds of green unstripped ramie in ten hours. Treated as No. 2 and weighed October 15, giving 12 pounds dried fiber.

Trial No. 4 was on 100 pounds of stripped stalks tested for quantity, without saturation, and began at 5.28 p.m.; stopped at 5.38 p.m. One stop of beaters, two minutes. Yield, 42 pounds of wet ribbons. Treated like No. 2 and weighed October 15, giving 6 pounds dried fiber.

Trial No. 5 was for quantity upon green unstripped stalks without saturation, 100 pounds being used. Began at 5.47 p.m.; stopped at 5.52 p.m; time, five minutes. Fiber after being dried weighed 5 pounds. This is equivalent to 1,200 pounds of green unstripped ramie per hour.

In the experiments upon the green unstripped ramie, without saturation, the machine had a tendency to clog; with saturation this difficulty was avoided. This machine is large and is better adapted to a central house to which ramie is hauled and worked than to field experiments.

TRIALS WITH THE ALLISON MACHINE NO. 2.

Soon after the trials given above, Captain Allison informed the committee that he had a smaller improved machine which he would be ready to test before the end of the season, and on Tuesday, December 18, a trial was made on this machine in which the number of parts of the large machine are greatly reduced. (See fig. 7.)

It consists of a series of pressure rollers, reciprocating brakes, rotary scutching and combing devices combined with feed and off bearing carriers mounted on a strong cast-iron frame. The ramie stalks are fed into the machine by means of an endless feed carrier. The first set of rollers are corrugated, and crush and split the stems; the second are smooth and crush the stalks. Back of the latter is a deflecting plate that turns the feed downward when it meets again the action of a third set of smooth crushing rollers, which further reduce the stems and firmly hold and feed gradually to reciprocating brake and scutching blades, where it is caught by a set of grip rollers. The rear end of the fibrous curtain as it descends is thrown out upon a set of deflecting plates and gradually drawn downward and one subjected to the action of a set of scutching and combing cylinders, where the rear end is again subjected to the action of the first set of scutching cylinders. The fibrous curtain descends in a perpendicular, and both sides are acted upon, while the rear end as it descends is subjected to the action of both sets of scutching and combing cylinders; and it is delivered to the off bearing carrier in ribbons.

Official tests were made upon dry ramie and green ramie with leaves. Besides these tests, a continuous run of several hours was made on badly frosted stripped stems. On account of the humidity of this climate it is very difficult to dry ramie stalks, and hence the material worked on was far from being in a desirable condition. The green stalks had also suffered from frost and the fiber injured in strength. Under these disadvantages the machine was tested.

Test No. 1 was upon 118 pounds of dried stalks. Total time of running, twenty-two minutes; time actually lost by beaters wrapping, four minutes; net time actually used in work, eighteen minutes. At such a rate it would work 322 pounds of dry ramie per hour; 3,220 pounds per day of ten hours. If the trouble with the beaters could be avoided, the daily work would equal 3,920 pounds. The 118 pounds of dry ramie gave 22 pounds dry ribbons.

Test No. 2 was on 80 pounds of green ramie with leaves, which were run through the machine in five minutes, this being equivalent to 960 pounds per hour, or 9,600 pounds per day of ten hours. The 80 pounds yielded 20 pounds wet ribbons. Besides these tests a continuous run was made on badly frosted ramie.

During the experiments tried above, considerable trouble was occasioned by the beaters wrapping and throwing the fiber to the rear. In taking down the machine after the trials, it was found that in its construction from drawings a mistake had

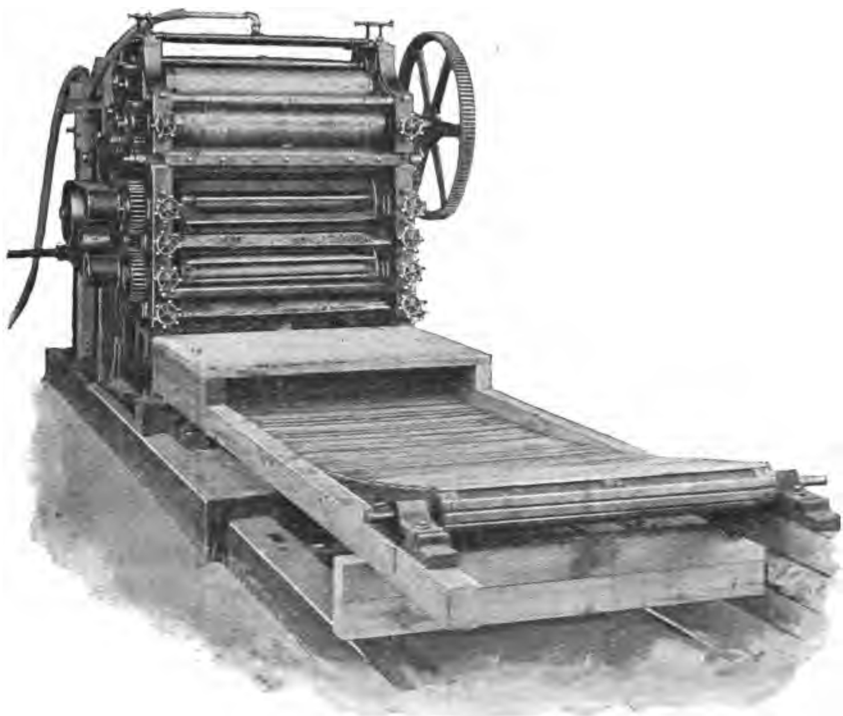

FIG. 7.—Allison machine, No. 2.

been made in placing the lower cylinders, attached to the scutching and combing devices, at least 2 inches out of the perpendicular, which defect had occasioned the trouble mentioned. This machine is on the same principle as the larger one, but simpler in construction and requiring less than one-half the power to run it. The feed and crushing rollers are at the same time 6 inches longer, thus increasing the capacity of the machine. With the material at hand and the defect in construction of the machine, the work done may be considered good.

REVIEW OF THE WORK DONE.

The work accomplished this year is far in advance of that performed by the machines on trial at this place two years ago. At that time none of the machines were capable of running without obstruction. In the trial of three machines there has been no disposition on the part of either to fail to work. The Textile Syndicate machine is easily run by a 4-horse power engine, and is capable of treating any quantity of stalks that can be fed it, without choking or stopping. Its greatest fault lies in the fact that it delivers the ribbons in a tangled, matted condition, requiring a large amount of time and patience to straighten them; besides at the end of each

fiber there was a piece of adherent wood which the machine failed to remove. The filament of the back is partly scraped, but not completely. These are serious objections, but by no means insuperable, as it is believed that mechanical skill can easily overcome these defects.

The large Allison machine delivers its fiber in good condition and better cleaned, but its immense size, and the power that it takes to run it, preclude the possibility of its being used in the field upon small experiments. In the small machine the size is considerably reduced, without destroying its efficiency, in order to adapt its work to the field, and to be run by a smaller power.

In addition to the official trials herein reported, the committee witnessed a large amount of work done by these machines, which afforded them an opportunity of making a careful study of the machine problem.

The committee desires to call special attention to the fact that in trials on green ramie the stalks were not denuded of leaves, while in the trials of two years ago, the stalks used by the three machines under test were required to be stripped. The Textile Syndicate machine without and the Allison machine with saturation, in the present test ran continuously without gumming, fouling, or breaking in any part, and gave evidence of ability to meet any demand in continuous running that might be made upon them.

It is, therefore, with pleasure that we report great progress in ramie machines since our last test; but neither of these machines are yet ready for successful operation on a small scale by farmers and planters; although with modifications that have already been suggested, and in part carried out, they will do far better work. The outlook is therefore promising.

CHAS. RICHARDS DODGE,
Special Agent, in charge of Fiber Investigations, U. S. Department of Agriculture.
WM. C. STUBBS,
Director of Mississippi Agricultural Experiment Station.
S. M. TRACY,
Director of Louisiana Sugar Experiment Station.

CONCLUSIONS.

In sifting the evidence, after a careful perusal of the above report, neither the English machine nor the Allison machine No. 1 should be regarded as fulfilling the requirements of a successful decorticator for the production of commercial fiber, the one because of the imperfect fiber it turned out, the other on account of its great weight, the number of attendants required, and the tendency of the wet fiber to wrap upon the cylinders. The action of the Allison machine No. 2 was much better, but the quality of the fiber should still be considerably improved, always bearing in mind, of course, that no machine-cleaned fiber will approach in appearance or cleanness the hand-cleaned China grass or commercial ramie. As stated in the body of the report, the considerations of quality and output are of equal importance. Output is dependent upon the machine alone—for a machine must turn out fiber in paying quantity to meet the requirements of a successful decorticator. Quality, however, is dependent upon both the machine and the cultivator, for immature or badly grown stalks will not produce good fiber, no matter how perfect the machine; and, on the other hand, an imperfectly constructed machine may produce low-grade fiber from the best of stalks. In this connection I regret that in the trials above recorded

the stalks operated upon were first year's growth, and hardly proper material for a *quality* test, and it is my sincere wish that another trial be held in 1895, when the perfected machines, and possibly other decorticators, may appear, the trials to be held upon second year's growth, which could not be obtained for the 1894 trials. The English machine has been modified and improved, as I have already stated. Mr. Allison has constructed an entirely new and improved machine which will be tested this season in the field on large areas.